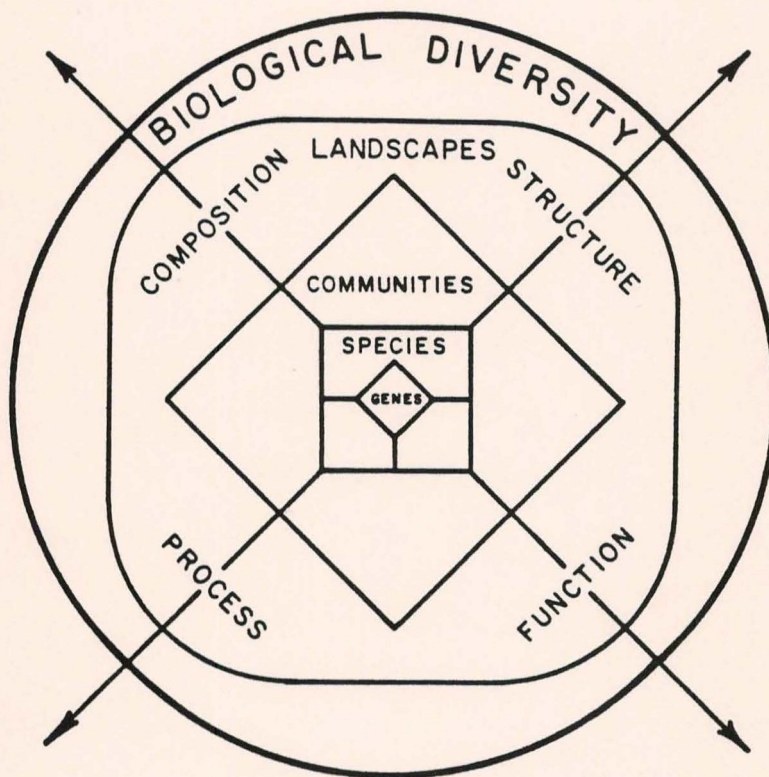


**BIOLOGICAL DIVERSITY**  
**TECHNICAL REPORT**  
*for*  
**THUNDER BASIN NATIONAL GRASSLAND**  
with recommendations for the  
**OIL AND GAS LEASING ENVIRONMENTAL IMPACT STATEMENT**

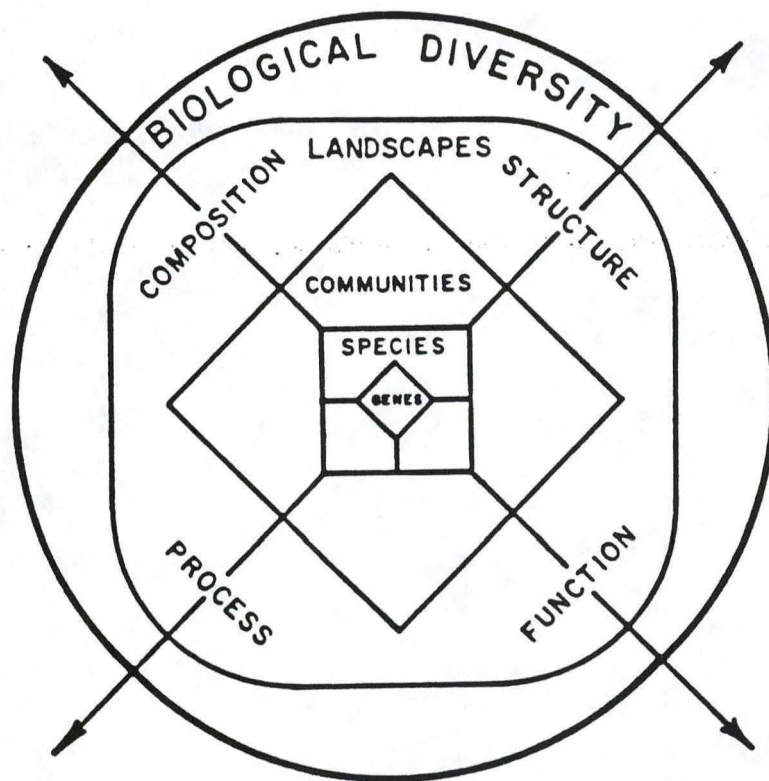


**MEDICINE BOW NATIONAL FOREST**  
Laramie, WY

December 11, 1992

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## EXECUTIVE SUMMARY

Biological diversity can be described at four scales on the Thunder Basin National Grassland. These are the landscape and community scales (Coarse Filter level) and the species and genetic scales (Fine Filter level). Biological diversity is expressed through attributes of ecosystem composition, structure, processes and functions at each scale. Composition, structure, processes and functions of ecosystems at the genetic and species scale, interact and aggregate upward to form functional ecosystems at the community and landscape levels.

Three hundred forty vertebrate animal species have been documented on the Thunder Basin National Grassland. This includes 29 species of fish, 6 amphibians, 15 reptiles, 228 birds (60 neotropical migrants) and 62 mammals. Little is known about terrestrial invertebrates, but information on species composition and distribution of aquatic invertebrates is available through several university studies, State of Wyoming and EPA water quality monitoring reports.

An estimated 250 species of vascular plants, representing floras from the Great Basin, northern and southern Rocky Mountains, Black Hills and Great Plains form a variety of plant communities. Twenty-two plant community types were identified in a formal classification study of the coal-bearing area of the upper Cheyenne River Basin. Additional community types, described from other areas, also occur here.

The plant community types can be grouped into large mapping units described by plant physiognomy. These useful descriptors for the landscape level include: deciduous riparian forest, deciduous riparian shrubland, riparian grassland, upland coniferous woodland, upland shrubland, shrub-steppe and upland grassland.

The matrix of the landscape consists of a mosaic of sagebrush shrub-steppe and upland grassland containing many community types. The matrix is divided along watercourses by corridors of deciduous riparian forest, deciduous riparian shrubland and riparian grassland. Coniferous woodlands and upland shrublands occur in patches in the matrix, forming islands of community mosaics differing sharply in species composition and physiognomy. These patches occur on outcrops of sandstone, scoria or shale bedrock along watershed divides. Coniferous woodland at the eastern border of the Black Hills forms a mosaic with sagebrush shrub-steppe in the transition to the matrix of the Powder River Basin.

Areas with special biological diversity were identified after coarse-scale vegetation maps were prepared and information on terrestrial and aquatic vertebrate species and communities was evaluated. Features of Standards and Guidelines in the Forest Plan; Threatened and Endangered Species laws; Wyoming Water Quality Regulations; standard oil and gas lease terms and special lease stipulations were examined to evaluate how biological diversity in different ecosystems, at different scales, would be maintained.

Characteristics considered for choosing areas with special biological diversity were: high species richness; unusual or uncommon species or communities; communities and species which occur on restrictive substrates; patch size, species and community composition, configuration, isolation and degree of landscape ecological integrity; estimated community sensitivity to change and recovery (resistance and resilience); and quality of animal habitat.

Areas identified as having special biological diversity characteristics were patches containing mosaics of woody perennial plant communities of trees and/or shrubs. These patches confer biological diversity at the landscape scale because their species composition and the vertical and horizontal structure of communities differ from the sagebrush-grassland matrix.

Two strategies for maintaining biological diversity across scales are recommended. The Coarse Filter Approach perpetuates biological diversity at the landscape and community levels; the Fine Filter Approach perpetuates biological diversity at the species and genetic levels. Use of the two approaches in concert is recommended as the best way to maintain ecosystem structure, composition, processes and functions in both the matrix and patches throughout the Thunder Basin National Grassland.

Forest Plan Standards and Guidelines, Federal Threatened and Endangered Species laws, State Water Quality Regulations, the terms of the standard oil and gas lease and special stipulations involving Controlled Surface Use and Timing Limitations were deemed adequate to protect existing biological diversity in the matrix and the more developed woodland patches. These regulations mainly protect populations of managed species (Fine Filter level) and the abiotic conditions which help sustain functioning ecosystems.

Application of the No Surface Occupancy special stipulation to selected patches, is the Coarse Filter strategy. Used in conjunction with the Fine Filter strategy for protecting populations of specific managed species, the reservation of areas for No Surface Occupancy accomplishes the following:

- prevents the fragmentation of landscapes and communities with high ecological integrity;
- protects the interactions and processes among communities within specialized patch mosaics;
- protects landscapes and communities which are sensitive to erosion and difficult or impossible to regenerate;
- retains options for future management choices which would be lost if oil and gas development disrupted the present surface patterns;
- contributes to values for recreation and scenic beauty
- preserves substantial areas of wildlife habitat which has uncommon characteristics in the Powder River Basin context
- provides valuable habitat for neotropical migratory birds which require coniferous woodland and shrubland (hawks, flycatchers, hummingbirds, swallows, warblers and others)

Four areas are recommended for No Surface Occupancy stipulations for maintenance of biological diversity. These are:

1. The Miller Hills (3520 ac)
2. Cow Creek Buttes (6970 ac)
3. Duck Creek Breaks (8960 ac)
4. Downs Area (5080 ac)

These four areas total approximately 24,500 acres or 4.2% of the Thunder Basin National Grassland. Reservation of these areas from oil and gas surface development will maintain old growth ponderosa pine woodland, aspen groves, woody draws and big and little bluestem grassland in the Duck Creek Breaks; ponderosa pine woodland, juniper woodland and a variety of shrub and grass communities on specialized sandstone, scoria and shale substrates in the Cow Creek Buttes and Miller Hills complex; and the shrub communities on the restrictive badland and canyon substrates in the Downs area.

As per the recommendation in this report, oil and gas development can proceed with minimum restrictions on over 95% of the Federal Surface of Thunder Basin National Grassland. The 4.2% recommended for No Surface Occupancy will have dollar costs in foregone lease fees and possible royalties. Total annual foregone Federal lease fees are estimated to be \$120,949 (Reddick and Crockett, 1992) or about \$5.00 per acre. Not restricting oil and gas development will have both immediate and cumulative environmental costs which are difficult to quantify monetarily.

Maintenance of the biological diversity resource is the foundation for sustaining and enhancing many other resource values including wildlife, recreation, scenic values, and forage production which are part of the Multiple-Use policy. The recommendations in this report represent a possible balance between mineral development including oil and gas, coal, bentonite, uranium and scoria, and the protection of the composition, structure, function and processes of areas with special biological diversity on the Thunder Basin National Grassland.

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## **CHAPTER I INTRODUCTION**

### **PURPOSE AND NEED**

The purpose of this report is to describe the biological diversity of the Thunder Basin National Grassland; to identify gaps in knowledge of biological diversity; and to evaluate projected impacts of oil and gas leasing on biological diversity.

### **LEGISLATIVE JUSTIFICATION FOR BIOLOGICAL DIVERSITY CONCERNS**

Legislative direction for conservation of biological diversity in the United States (Table 1.1), began with state game conservation laws and the Forest Reserve Act of the late 1800s. The Forest Reserve Act was a reaction to the rapid loss of forests on public land at that time (Forest Reserve Act, 1891).

The conservation of biological diversity was first articulated in legislation to conserve species, and more recently in legislation to conserve ecosystems. Although the term "biological diversity" does not appear directly in The National Forest Management Act (1976); the Multiple Use and Sustained Yield Act (1960) or the National Environmental Policy Act (1969) Act, concern for elements of biological diversity appear in many places in these legislative acts. The NEPA requirements for consideration of short term, long term and cumulative effects of projects relate to concerns which affect biological diversity. Added to past concerns for threatened and endangered species is growing awareness of the values of genetic biological diversity and the role of biological diversity at large (landscape) scales.

This biological diversity assessment document, is prepared in support of the EIS for Oil and Gas Leasing on the Thunder Basin National Grassland. The decision based on this EIS will amend the 1985 Medicine Bow National Forest Plan. The need for a biological diversity assessment arose from responses to the DEIS and is a logical part of the evolution of the process for seeking a balance between commodity resource use, economic development and the conservation of biological resources on National Forest System Lands.

### **PHILOSOPHICAL AND ETHICAL JUSTIFICATION FOR BIOLOGICAL DIVERSITY CONCERNS**

In addition to legislative requirements for conservation of biological diversity, there are the dimensions of environmental philosophy and new Forest Service Program Direction which have coevolved with the legislation. Specific elements of new Forest Service Program Direction

**TABLE 1.1 Synopsis of major legislation to conserve species and ecosystems (Adapted from Cooperrider, 1991)**

---

<b>Species</b>	<b>Legislation</b>
Large game mammals, birds & fish	State Game Protection Laws (1700s)
Wild animals	Lacey Act (1900)
Wild birds	Migratory Bird Treaty Act (1918)
Fish	Fish Restoration and Management Act (1950)
Plants & animals	Endangered Species Act (1973)
All species	

<b>Ecosystems</b>	<b>Legislation</b>
Forest Lands	Forest Reserve Act (1891)
Grazing Lands	Taylor Grazing Act (1934)
Wildlife Sanctuaries	Fish & Game Sanctuary Act (1934)
Wilderness	Wilderness Act (1964)
Rivers	Wild and Scenic Rivers Act (1964)
Coastal Areas	Marine Protection Research and Sanctuaries Act (1974)
Forest Lands	National Forest Management Act (1976)
Rangeland	Federal Land Management and Policy Act (1976)
All ecosystems	Multiple Use and Sustained Yield Act (1960)
	National Environmental Protection Act (1969)

---

include the ecosystem management policy announced by Forest Service Chief Dale Robertson on June 4, 1992; the 1990 Recommended Resources Planning Program; and the 1992 Regional Guide for Region 2. The changes in attitudes and paradigms, from past views which were mainly oriented toward commodity production and economics, to an ecosystem management approach, has important implications for decisions on issues in which the interests of biological diversity may differ from the interests of resource extraction.

Hal Salwasser, director of the New Perspectives program from the Washington Office, said "we must put conservation of biological diversity into its right and proper context: stewardship of lands and resources to sustain the wide array of values and uses needed by this and future generations.....The goal is, in the words of Aldo Leopold, a state of harmony between people and the land." He also discussed sustainability - sustainability of the environmental security of the the region, sustainability of meeting the needs of people for commodities and spiritual growth, and sustainability of the resource for economic development. He said "...conserving biological diversity is the right thing to do for the land..and it is the right thing to do for people..." (Rocky Mountain Regional Biological Diversity Symposium; (Salwasser, 1991).

The 1990 Resources Planning Act (RPA) Recommended Program states "The USDA Forest Service has the responsibility to be a leader in the conservation of resources and environmental values of the Nation's forests and rangelands (S-1). The report cites biological diversity as a subject "where there is considerable uncertainty about the magnitude of future impacts and where knowledge for management is imperfect" (S-11). As a response to the contemporary issue of biological diversity, the direction is that "The Forest Service will increase its role in developing knowledge, implementing conservation measures, and demonstrating management approaches that conserve specific elements of biological diversity" (S18) (The Forest Service Program for Forest and Rangeland Resources: A long-term strategic plan (1990).

George Leonard, Associate Chief of the Forest Service, talked about the question of acceptable short-term social costs for the long-term investment in a biologically rich future. He said that conserving biological diversity will not be either cheap or without controversy. He said that "if we don't sustain diverse forests and rangelands we will not ultimately sustain meaningful human life". (Leonard, 1990)

An interagency report between the Forest Service and Bureau of Land Management entitled *America's Biodiversity Strategy: Actions to Conserve Species and Habitats* (1992) concluded that both the public and private sector have roles in maintaining and restoring, where practicable, biodiversity for its intrinsic worth, for ecosystem stability and for human health and well-being.

Special reports on biological diversity have been prepared for projects on the George Washington National Forest - Region 8 (1991); the Beaverhead National Forest - Region 1 (1991); and the Custer National Forest - Region 1 (1990). An ecosystem management approach prepared for the Umatilla, Malheur and Wallowa-Whitman National Forest - Region 6 (1992) includes many elements for perpetuation and protection of biological diversity and ecological function.

The importance of recognizing, understanding and managing for biological diversity on a variety of scales is an important component of the ecosystem management initiative in the Forest Service. Perpetuation of biological diversity at all scales is a critical element in attaining the goal to sustain diverse and resilient ecosystems with a desired mix of biological communities (Estill and Montrey, 1992).

Holmes Rolston III (1986), a noted environmental philosopher at Colorado State University, points out that while humans have the powerful ability to change the natural order, they are also equipped with a conscience, not given to non-human creatures. With this conscience, humans must wisely direct and balance resource budgets. These budgets include the business resource as well as the natural resource. (Rolston, 1986 pp. 164-175).

#### **DEFINITIONS OF BIOLOGICAL DIVERSITY**

There are many definitions of biological diversity. The theme common to all is the description of the variety of life. Some definitions focus on species, while others include larger scales, placing the species in the context of ecosystems within larger landscape units and processes which sustain these units over time. Some agency definitions of Biological Diversity are in Table 1.2.

Consideration of these three agency definitions of biological diversity reveals recognition not only of species population structure and composition, but also multiple scale considerations from genes to large landscapes and the importance of processes and functions. Processes and functions which cause change in biological diversity over time in defined spatial areas, are important considerations for management.

#### **METHODS OF ANALYSIS**

This biological diversity assessment was prepared by an interdisciplinary team consisting of the Medicine Bow National Forest Ecologist, Soil Scientist, and the Fisheries Biologist and the Douglas District Wildlife Biologist. Recent Oil and Gas FEIS documents and records of decision from the Custer National Forest (Little Missouri National Grasslands, 1991) and the Pike and San Isabel National Forest (Comanche and Cimarron National Grasslands, 1991) were reviewed.

**TABLE 1.2      DEFINITIONS OF BIOLOGICAL DIVERSITY**

Source	Definition
OTA (1987)	Biological diversity refers to the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different items and their relative frequencies. Thus, the term encompasses different ecosystems, species, genes and their relative abundance.
R-2 (1992)	Biological diversity is the full variety of life in an area, including the ecosystems, plant and animal communities, species and genes, and the processes through which individual organisms interact with one another and with their environments.
BLM (1988)	Biodiversity is the aggregate of species assemblages (communities), individual species, and genetic variation within species and the processes by which these components interact within and among themselves; for purposes of classification, biodiversity can be divided into three levels: community diversity (habitat, ecosystem); 2. species diversity, and 3. genetic diversity within species; all three levels change with time.

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OTA (Office of Technology Assessment); R-2 (Biological Diversity Assessment for the Regional Guide - Rocky Mountain Region, USDA Forest Service); BLM advisory committee, 1988   Davis, CA

Information on species, communities and landscapes was obtained from specialist reports prepared for the Oil and Gas EIS (Byer and Cartwright, 1992; Cartwright, 1992; Edwards, 1991A, 1991B; and Speas, 1991, 1992), special field work and literature reviews. Specific information on wildlife populations was obtained from the Wyoming State Game and Fish Department; the U.S. Fish and Wildlife Service; the coal mines on the Thunder Basin National Grassland and the Douglas Ranger District Files. Information on fish, amphibians and macroinvertebrates was obtained from the Wyoming Game and Fish Department; the Wyoming Water Center; the University of Wyoming; and special surveys. Information for the vegetation analysis was from floristic surveys conducted by the Rocky Mountain Herbarium at the University of Wyoming; field work for vegetation classification from the Rocky Mountain Station in Laramie, aerial photography and field ground-truthing.

Map overlays were prepared to analyze the patterns and interactions of the following information:

1. geologic substrate
2. oil and gas plays
3. currently producing wells and plugged holes
4. reasonable foreseeable development (RFD) from the Draft EIS
5. vegetation patterns
6. species distribution for bald eagles, golden eagles and ferruginous hawks
7. species distribution for sage grouse leks, mountain plovers and prairie dogs
8. wildlife exclosures
9. surface mining (coal, uranium, bentonite, scoria, sand)
10. wetlands associated with riparian areas
11. riparian corridors

Analysis procedures included:

1. consideration of the direction in the Medicine Bow National Forest Plan, the National Forest Management Act, the National Environmental Protection Act and other applicable laws
2. application of both the Coarse Filter Approach (landscape and community level) and the Fine Filter Approach (species) (Hunter, 1991)
3. consideration of information on biological diversity at the landscape, community, species and genetic level
4. consideration of the relationship of biological diversity to the underlying geologic and geomorphic composition and structure of the landscape
5. consideration of spatial and temporal scales and the influence of history on present biological diversity

6. identification of landscape areas of unique biological diversity; identification of community types with special biological diversity characteristics; identification of species which are most likely to be affected by changes in landscape or community patterns
7. comparison of present and projected oil and gas leasing areas to patterns of biological diversity at all scales
8. evaluation of possible impacts on biological diversity from oil and gas leasing

#### **SCOPE OF THE BIOLOGICAL DIVERSITY ASSESSMENT**

Biological diversity for the Thunder Basin National Grassland was assessed in the context of four scales: 1. landscape; 2. community; 3. species and 4. genetic. Appropriate aspects of ecosystem process and function were considered for each scale.

Broad ecosystem approaches to biological diversity analyses may fail to accommodate habitat linkages, site specificity or spatial arrangement within landscapes. Single species approaches (threatened and endangered species, indicator species or featured species) may fail to represent habitats or conditions necessary for viability of all species and do not address habitat fragmentation or other spatial problems (Probst, 1991). The approach used for this biological diversity assessment is to assess biological diversity as completely as possible at four scales (landscape, community, species and genetic) to include both Coarse-filter and Fine-filter considerations (Hunter, 1991). Structure, composition, function and process attributes are considered for each scale. It is recognized that information is lacking in many areas. We attempted to identify critical information gaps and to clearly separate site specific data, from broad-scale data, or interpretations of data.

This biological diversity assessment is in the vanguard for this kind of analysis for lands administered by National Forests. Identification of focal components, parts and processes at the landscape, community, species and genetic scales is a keystone of this document.

The relationship of the four scales to ecosystem structure and composition, process and function; why biological diversity is important and its application to ecosystem management are discussed in Chapter 2. Chapter 3 is a description of the biological diversity of the Thunder Basin National Grassland at the four scales, integrating available information on ecosystem structure and composition, process and function. Historical considerations and landscape models are also discussed in Chapter 3. Criteria for identifying areas with special biological diversity characteristics are presented in Chapter 4. Environmental Consequences of Oil and Gas Leasing to biological diversity are explored in Chapter 5. Cumulative Effects are discussed in Chapter 6. Chapter 7 contains recommendations for mitigating effects

of oil and gas development on biological diversity with respect to the four scales and their attributes.

## **CHAPTER II**

### **BIOLOGICAL DIVERSITY AND ECOSYSTEM SCALES, STRUCTURES, FUNCTIONS AND PROCESSES**

#### **INTRODUCTION**

The Rocky Mountain Regional Guide provides direction for National Forest Plans in Region 2. The Biodiversity Assessment for the Rocky Mountain Regional Guide recognizes an organizational hierarchy for biological diversity based on the community, species and genetic scales. It recognizes the interrelated scales of the regional, landscape, watershed and local site for ecosystem management (Biological Diversity Assessment, 1992).

For the Thunder Basin National Grassland Biological Diversity Assessment, the structure, process and function of specific ecosystems which have defineable biological diversity attributes are discussed for the landscape, community, species and genetic scales. Table 2.1, and the following discussion, summarize major features of specific attributes for biological diversity characteristic of each of these four levels of scale.

The Coarse-Filter Approach is a strategy for maintaining and managing biological diversity. This approach is based on articulation of landscape and community level land units. The premise is that maintenance of biological diversity at larger landscape and community levels should protect viable populations of most species. For the remaining species (those that "fall through" the pores of a coarse filter), a series of fine filters are needed. Fine filters are individually tailored conservation plans for those species requiring them. The federal endangered species program exemplifies the Fine-filter Approach (Hunter, 1991).

Advantages of the Coarse-Filter Approach are cost and efficiency - it is more cost-effective to manage ecosystem units than to manage a myriad of endangered species scattered over the landscape. The Coarse-Filter strategy also maintains the integrity of whole ecological systems, thereby sustaining the ecological and evolutionary context in which organisms exist (Hunter, 1991).

Ecosystems occur at all scales, from the genetic scale through the level of the large systems which are used to describe the biosphere. An ecosystem is a real time-space object with dimensions of soil and landform, organisms and climate as well as the processes which occur over time to make these into functional wholes (Rowe, 1992).

The genetic component and the physiological interactions of organisms and environment are contained within the organisms found in ecosystems. At larger scales, organisms occur in groups called communities. Communities, in turn, aggregate into landscapes. It is convenient to

**Table 2.1 HIERARCHY OF ORGANIZATION FOR DESCRIPTION OF BIOLOGICAL DIVERSITY**

<b>Level</b>	<b>Attribute</b>	<b>Attribute Descriptors</b>
<b>Landscape</b>	<b>Structure &amp; Composition</b>	Matrix; patch size, type and arrangement; corridors, nodes; heterogeneity; connectivity; fragmentation characteristics
	<b>Process</b>	Climate change; geomorphic processes; patch transitions; disturbance intensity, frequency, areal extent; patch persistence
	<b>Function</b>	Biomass production and nutrient cycles; energy flow
<b>Community</b>	<b>Structure and Composition</b>	Species composition; physical community structure; guilds; life form composition; physiognomic characteristics
	<b>Process</b>	Succession; herbivory; disturbance
	<b>Function</b>	Biomass production and nutrient cycles; energy flow
<b>Species</b>	<b>Structure and Composition</b>	Species richness and evenness
	<b>Process</b>	Competition; population dynamics; dispersal
	<b>Function</b>	Biomass production; nutrient cycles; energy flow
<b>Genetic</b>	<b>Structure and Composition</b>	Gene pool characteristics
	<b>Process</b>	Mutation; evolution; speciation; isolation
	<b>Function</b>	Gene flow

The Coarse-Filter strategy for maintaining biological diversity is applied to the landscape and community scales; the Fine-Filter strategy is applied to the species and genetic levels.

define ecosystems in the context of a physical map unit composed of living and non-living parts at the community and landscape scales.

Ecosystem fragmentation occurs when portions of a landscape are biologically isolated, and biological processes or functions are impaired. This may occur on a landscape, watershed or Forest Plan Diversity Unit scale, where corridors are blocked, the matrix is fragmented or patch size, juxtaposition, seral stage or ecological condition are changed. Fragmentation may be expressed in the process and function contexts as genetic isolation, interference with gene flow, or changes affecting energy and material flows within ecosystems or across ecosystem boundaries (Knopf and Smith, 1992).

The maintenance of minimum viable populations is a concern for biological diversity. Comprehensive studies to determine minimum viable populations will be possible for only a few selected species. Much of the biological diversity responsible for ecosystem health and sustainability is "invisible diversity", found in microorganisms or invertebrate species. A practical alternative is managing for large and well-distributed populations, using a landscape and ecosystem approach (Probst and Crow, 1991).

The task of identifying functional ecological groups, minimal structure frameworks, animal guilds, keystone species, critical link species and process relationships which support ecosystem sustainability (West, 1993) lies largely in the future. The analyses presented in this document should provide a basis for future biological diversity evaluation to understand these factors and apply them to management.

#### **ECOSYSTEM STRUCTURE/COMPOSITION AND BIOLOGICAL DIVERSITY**

Biological diversity can be described with reference to the structure and composition of ecosystems. The kinds of descriptors and ways of measuring biological diversity differ depending on the scale being described (Magurran, 1988).

At the landscape level, which aggregates communities from a scale of a few square kilometers, to watersheds or regions, ecosystem structure and composition is described by characteristics of the matrix, patches, corridors and node structure of the landscape under consideration. Biological diversity at this scale is referred to as gamma diversity for units such as watersheds or islands. Regional diversity (also called epsilon diversity) is the total diversity for a group of areas for which gamma diversity has been assessed. Gamma and epsilon diversity are statistics which can be computed from measures of biological diversity at smaller scales, but they can also be used as conceptual qualitative descriptors.

At the community level, biological diversity of ecosystems can be described by evaluating species composition and physical community

structure. The variation in species composition between two communities along an environmental gradient is called beta diversity. It provides an index of species differences between contrasting communities.

At the species level, biological diversity can be described using species richness (kinds of species) or species evenness (distribution of abundance or importance of different species) in the context of communities. These measures can be combined into a single statistic that measures species diversity at the local (alpha) level. This provides a measurement of the numbers of kinds of items. Species richness or evenness can be evaluated in the context of the community scale or the landscape scale.

The structure and composition of the gene pool, and the presence and variation of configurations of DNA for a species, is the focus of biological diversity at the genetic scale.

The Forest Plan recognizes vertical diversity .." the complexity of the above-ground structure of the vegetation" and horizontal diversity .."the number of plant communities or successional stages or both". These concepts are both related to the structure and composition of ecosystems at the species and community levels and have their basis in the CFR Regulations (Section 219). They do not address ecosystem processes or functions.

#### **ECOSYSTEM PROCESSES AND BIOLOGICAL DIVERSITY**

Processes cause change in structure and composition of species, communities and landscapes over time. That change may be expressed as changes in patches which effect change in the matrix at the landscape level; as succession of species resulting in different community types at the community level; as population changes at the species level or as mutation, evolution, and speciation at the genetic level. As structure and composition changes, functions such as biomass production or energy flows will also change.

Specific processes which cause changes in landscape structure may include climate change, geomorphic processes, or large scale disturbances such as fire, grazing, or timber harvest. Similar smaller scale disturbances including fire, grazing or timber harvest, succession, and competition among populations are examples of processes affecting the community level. At the species level, the dynamics of populations, affected by birth, death, predation, disease, stress and competition among individuals of the same or different species, and dispersal, are the keystones of processes affecting the presence of species and subsequently the biological diversity characteristics of communities and landscapes.

Processes are nested from the genetic to the landscape level and are intricately linked to ecosystem structure. For example, mutations which affect the ability of individuals (and therefore populations) to survive, compete and persist in the landscape, will affect species richness and evenness, and will be measured as changes in community composition and structure at local scales, and as landscape composition and structure changes at larger scales.

#### **ECOSYSTEM FUNCTIONS AND BIOLOGICAL DIVERSITY**

Ecosystem functions describe the flow of energy and materials within and between ecosystems at any scale. This may include the exchange and flow of genetic material, physiological exchange of energy and materials between an individual and the environment or the aggregation of these functions expressed as biomass production or nutrient cycling at the community or landscape level.

These functions of ecosystems are dependent on the structure and composition of the ecosystems, and the processes which occur as materials and energy are exchanged. The nature and stability of biological diversity is associated with the integrity of these ecosystem functions. For example, if there are changes in the flow of energy and materials within an ecosystem due to introduction of livestock, removal of livestock, predator control, surface mining, road construction, use of fertilizer, herbicides, changes in water flow or water quality, the result will be changes in the composition and structure of the communities and landscape with consequential changes in biological diversity.

#### **IMPORTANCE OF BIOLOGICAL DIVERSITY AND APPLICATION TO ECOSYSTEM MANAGEMENT**

The foregoing discussion demonstrates that biological diversity is not a simple concept which can be applied in a general sense to ecosystems. Rather, it is a suite of features of composition, structure, process and functions of ecosystems whose properties differ by scale. It is also interactive - the small scale structures, processes and functions affect the larger scales and vice versa. Biological diversity is a dynamic property of landscapes - change over time is to be expected and should be planned for.

Management has a direct effect on whether biological diversity is maintained, increased or decreased. By law, the Forest Service is directed to develop management prescriptions which "where appropriate and to the extent practicable shall preserve and enhance the diversity of plant and animal communities....so that it is at least as great as that which would be expected in a natural forest" (36 CFR 219.28). The overall concept with regard to biological diversity, may be interpreted as management of multiple uses within the range of natural variability of ecosystems to permit, as much as possible, the maintenance of natural biological diversity to minimize impacts on ecosystems.

Often the value placed on particular kinds of biological diversity is a function of management goals. Different species may have different values for different reasons when considered from a management viewpoint. In addition to the values placed on species from a management perspective there is also the viewpoint, held by some, that all species should have value and should have a right to exist, regardless of the goals and uses that humans make of them or their habitat (Sample, 1991).

Reasons to conserve and perpetuate biological diversity have been promoted recently in literature and at symposia (Hudson, 1991; Rolston, 1988). These reasons fall into three general categories: 1. direct benefits to humans (sources of medicines, new genes to improve domestic varieties of plants or animals, recreation and spiritual well-being) 2. indirect benefits to humans by preserving processes such as soil formation, water purification, atmospheric purification and other ecosystem level maintenance services 3. ethics and stewardship (the belief that allowing natural systems to structure themselves and function with a minimum of human interference is the right thing to do). The interactions of these reasons with specific management contexts forms the basis for decisions.

The bottom line for ecosystem management which considers biological diversity is whether or not viable populations of species persist on the landscape in a way that perpetuates the structure, processes and functions of ecosystems at all scales. Thus, each management decision must be evaluated in the context of its direct, indirect and cumulative effects on local populations of species as well as effects at larger scales (watersheds and regional scales which are part of the landscape scale concept). The impacts of these effects over time on biological diversity deserves careful consideration.

Some management practices are already in place to conserve or enhance populations of plants or animals which are known to have narrow ecological requirements or which have low populations and/or low potential for population increase. In addition to consideration for these organisms, it is also important to evaluate potential changes in biological diversity for more common organisms with regard to their distributions and their occurrence on the landscape, and to consider the "big picture" of how different communities contribute to the biological diversity at the landscape scale.

## **CHAPTER III**

### **DESCRIPTION OF BIOLOGICAL DIVERSITY ON THE THUNDER BASIN NATIONAL GRASSLAND**

#### **ORIENTATION**

##### **Geographic and Watershed Setting**

Ecoregions are large biophysical regions defined by climate as the primary environmental factor. Large-scale geology, soil and vegetation patterns serve as secondary delineators for ecoregions.

The Forest Service uses the Bailey Ecoregion concept, in which climate is the primary divider for ecosystems, as a basis for National Land Classification (Bailey and Cushwa, 1982). Two Sections of this classification apply to the Thunder Basin National Grassland (Fig. 3.1):

##### **Dry Domain**

##### **Steppe Division**

##### **Great Plains Short-grass prairie Province**

##### **Gramma-needlegrass-wheatgrass Section (3111)**

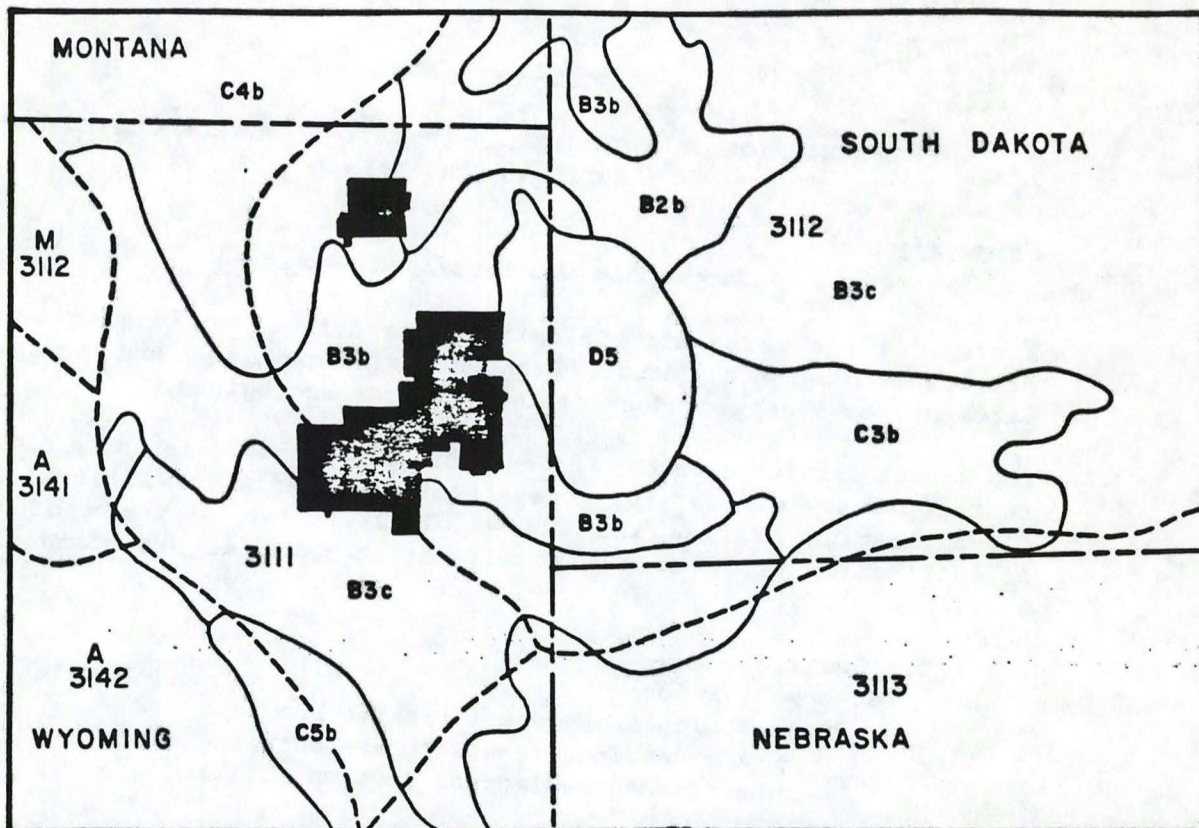
##### **Wheatgrass-needlegrass Section (3112)**

This classification system recognizes short-grass prairie, Palouse Grassland, Intermountain Sagebrush, and Mexican Highlands Shrub Steppe as provinces within the Dry Domain Steppe division. Figure 3.1 shows the relationship of the TBNG to this large-scale classification of Ecoregion and Land Surface Forms.

The Thunder Basin National Grassland (TBNG) is classified mostly in the western portion of the Northwestern Great Plains Ecoregion of the west-central United States using the EPA Ecoregion system (Omernik, 1987). The northeastern area of the Thunder Basin National Grassland, along the western boundary of the Black Hills uplift, is classified in the Middle Rockies Ecoregion using the EPA classification.

The TBNG is within the Missouri Drainage Basin. The major watershed on the TBNG is the Cheyenne River. Smaller areas lie within the Belle Fourche, Powder River and Little Missouri drainage systems. Elevations range from approximately 4000 feet at the southeast corner of the TBNG, to a maximum of 5200 feet on the surface of the Rochelle Hills. The maximum elevation in the Spring Creek area is about 4200 feet.

In this report the following areas will be referenced: 1. the Spring Creek Area; 2. the Cheyenne River basin (CR Basin) [exclusive of the Upton-Osage area in the Northeast corner] and; 3. the Upton-Osage area (U-O Area) which includes the part of the Thunder Basin National Grassland mostly on Cretaceous substrates in the northeast corner of the planning area. Most of the U-O area drains into the Cheyenne River, but it has a different geologic substrate (Figure 3.2).



#### ECOREGION

Dry Domain

Steppe Division

Great Plains Short-grass Prairie Province

3111 - grama-needlegrass-wheatgrass Section

3112 - wheatgrass-needlegrass section

#### LAND SURFACE FORM

B3b - Plains with hills (300-500 feet relief, 50-75% of gentle slopes on lowland) (Western portion of TBNG on Wasatch Formation)

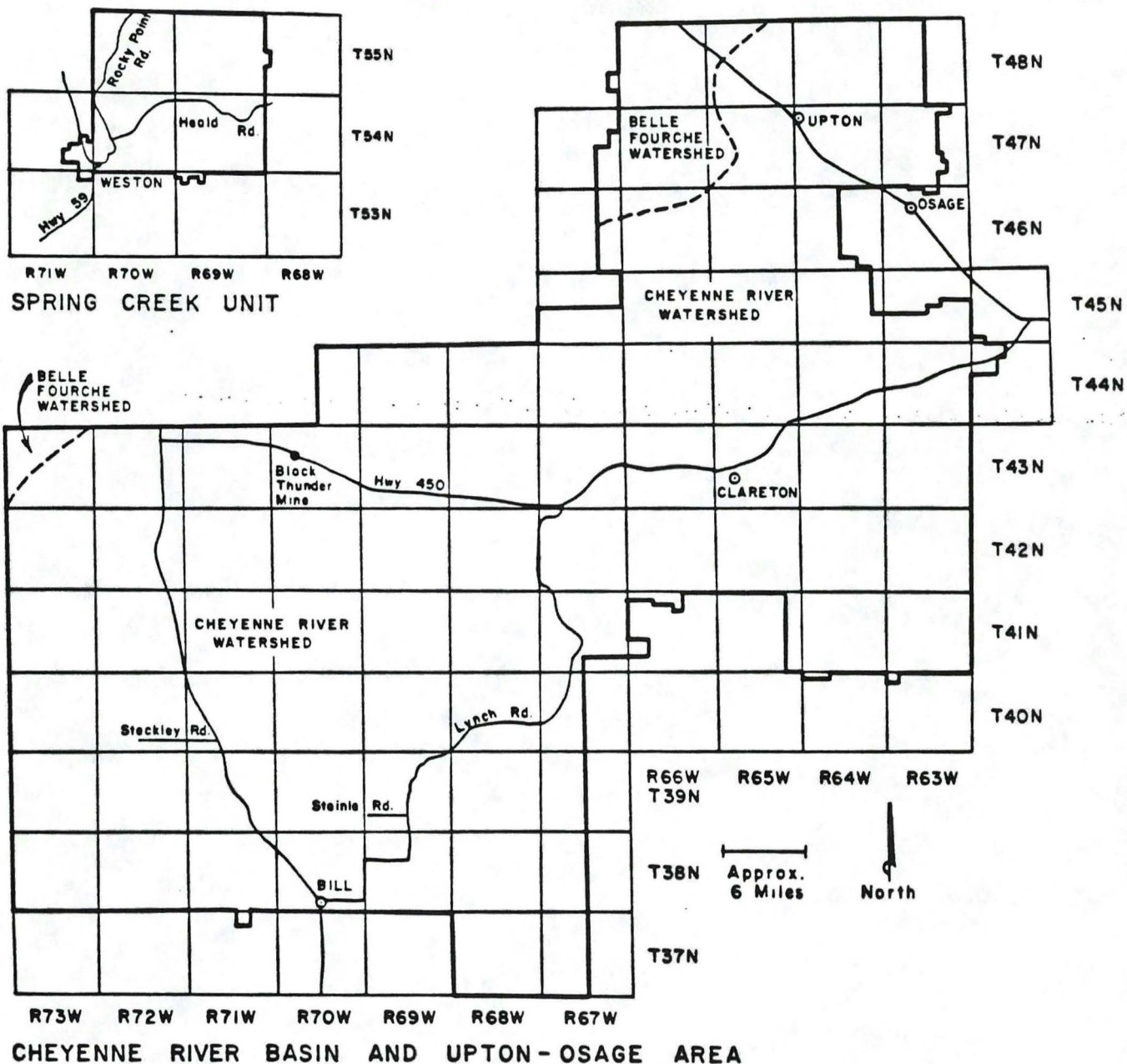
B3c - Tablelands with moderate relief (300-500 feet relief, 50-75% of gentle slopes on upland) (Central and most of eastern portion of TBNG on Fort Union Formation and Cretaceous formations excluding the Black Hills uplift area)

C4b - Open high hills (500-1000 feet relief, 50-75% of gentle slopes as in lowland) (Spring Creek)

D5 - Low mountains (1000-3000 feet relief) Upton area

From: USFWS. 1982. Ecoregions and land-surface forms of the United States. Map produced by the USFWS Office of Biological Services, Eastern Energy and Land Use Team and the Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO

**FIGURE 3.1 U.S. FOREST SERVICE ECOREGIONS FOR THE THUNDER BASIN NATIONAL GRASSLAND**



**FIGURE 3.2 REFERENCE MAP FOR THUNDER BASIN NATIONAL GRASSLAND.**  
Major roads, towns, watersheds and landmarks shown on this map are repeated in subsequent maps, without labels.



### Geologic setting

The TBNG is in the Powder River Geologic Basin, a downwarp of sedimentary rocks between the Black Hills uplift and the Bighorn Mountains. The geologic basin filled with deep sediments during the Paleocene and Eocene epochs. The surface geology is shown in Figures 3.3 and 3.4.










The Wasatch Formation (Eocene) is the substrate for most of the southwestern and western portion of the CR Basin. The upper part of this formation, found in the western part of the Cheyenne River Basin forms uplands near the headwaters of the Cheyenne River. The lower members of the Wasatch formation contain coal beds, and sandstones which form the Rochelle Hills.

Older rocks of the Fort Union Formation (Paleocene) lie below the Wasatch Formation and are the substrate for most of the central and southeastern area of the Cheyenne River Basin. The Fort Union Formation consists of three members. The uppermost member is the Tongue River member, which contains coal, and yellowish colored sandstones which are also part of the Rochelle Hills. The contact of the Wasatch and Fort Union formations is where the coal mines are located in the central portion of the CR Basin. Below the Tongue River Member and geographically east is the older Lebo member consisting of grey shale and claystone with light colored sandstone beds and thin coal beds. In many areas the Tongue River and Lebo members are mixed together (undivided).

The Paleocene environment in which these formations were deposited is believed to have been a trunk river with many tributaries flowing over a rather flat landscape with swampy vegetation (Moore, 1992). Shale and claystone sediments below ancient Lake Lebo form the badlands in the Downs Area. Coal beds developed where organic material accumulated. Much of the rest of the landscape was formed by river deposits which ranged from coarse sand to clays and silts. This ancient landscape is exposed by modern erosion to form "badlands" in Cow Creek Buttes, the Downs area, along the Cheyenne River and in the Spring Creek Unit.

The lowest and oldest member of the Fort Union Formation is the Tullock Member which is gray to yellow sandstone and light colored shales. This forms the substrate in the vicinity of the Lynch Road and eastward to approximately the alignment of State Highway 116. The Spring Creek area consists mostly of the Lebo and Tullock members, either alone or undivided. This contrasts with the more southerly CR Basin area where the younger Tongue River and Lebo members tend to be undivided and the light colored sandstones and interbedded shales of the Tullock member form a distinct north-south band 10-15 miles wide east of the Tongue River and Lebo members.

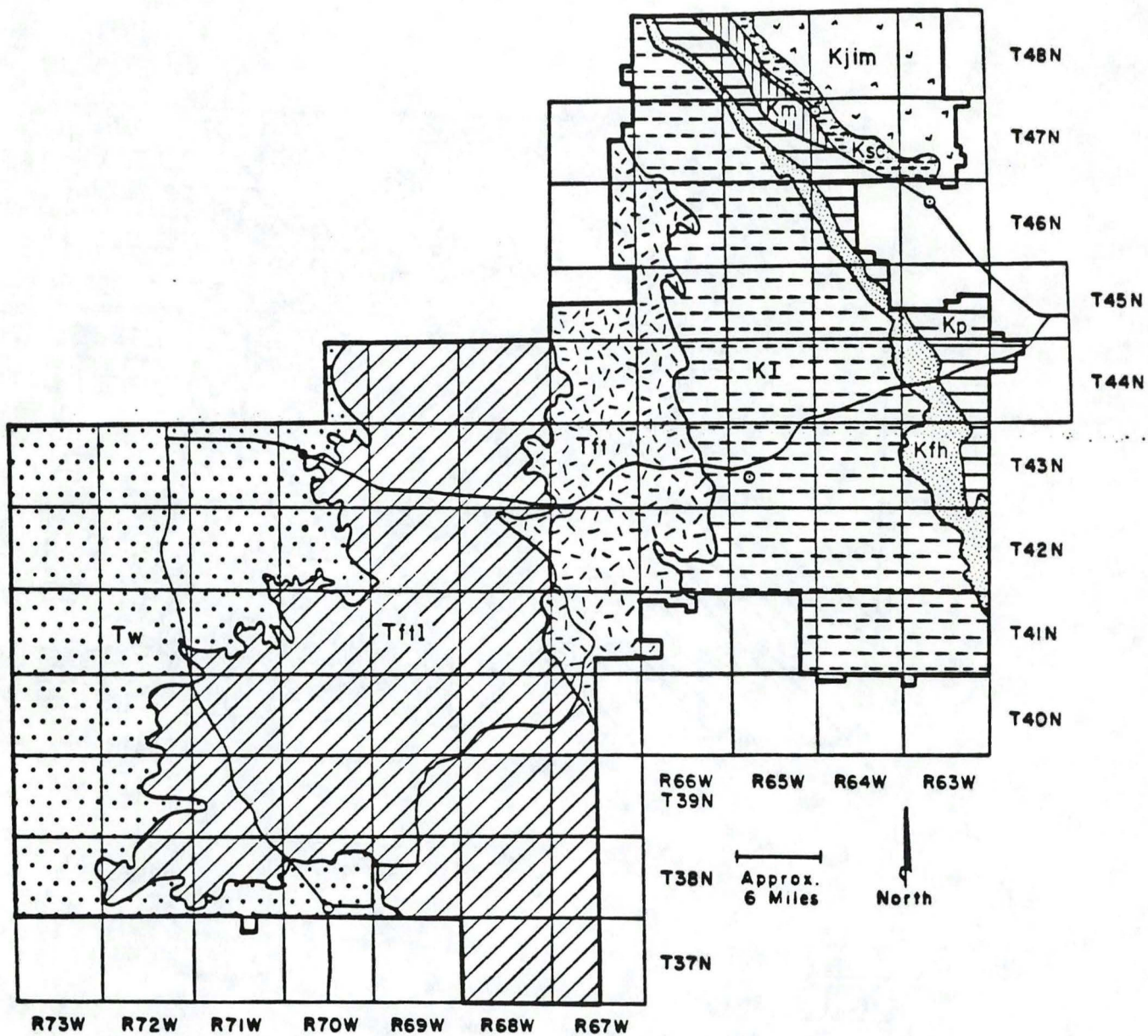
The northeastern third of the TBNG (Upton-Osage area) is underlain by several upper and lower Cretaceous Formations. The Lance Formation (Upper Cretaceous) contains non-marine concretionary sandstones and shale. It forms a wedge-shaped band 6 to 20 miles wide east of the

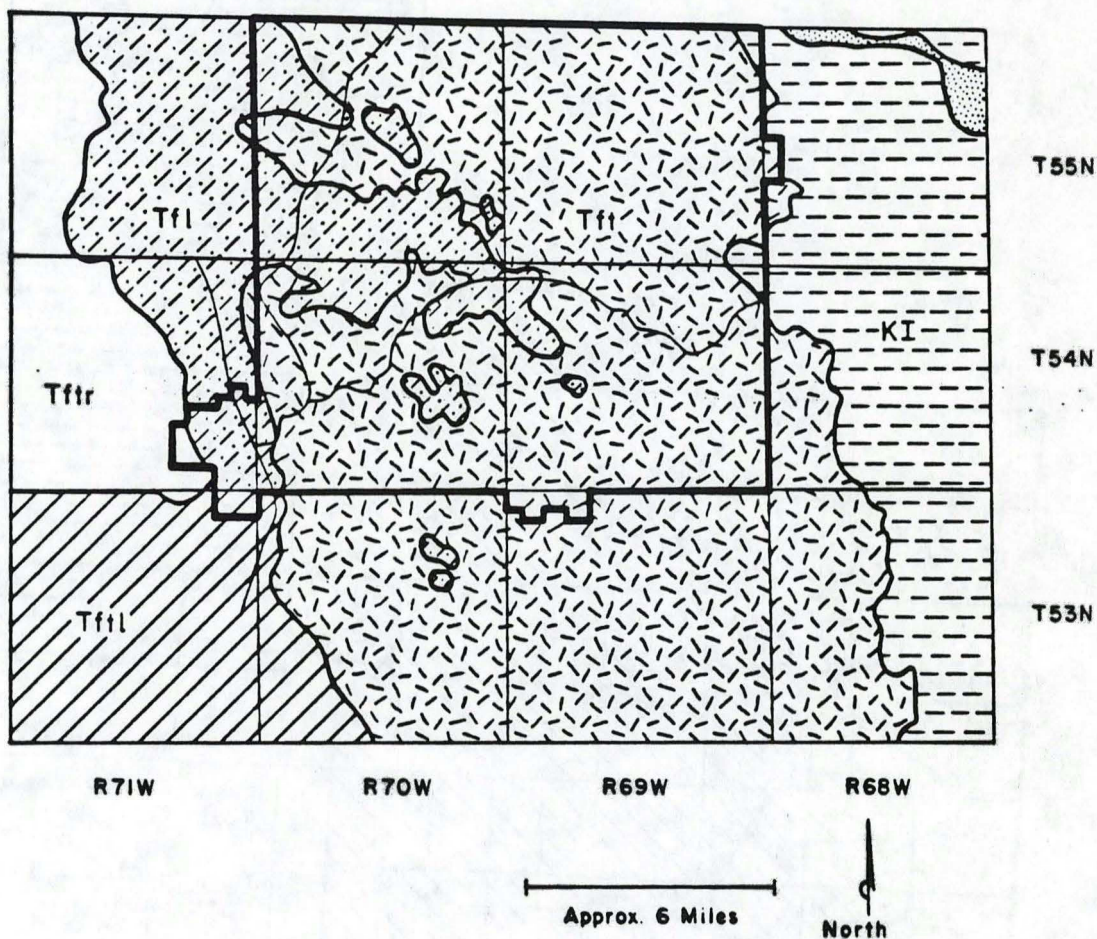
	Wasatch Formation		Eocene
	Fort Union Formation	Tongue River & Lebo Members	Paleocene
	Fort Union Formation	Tullock Member	Paleocene
	Lance Formation		Upper Cretaceous
	Fox Hills Sandstone		Upper Cretaceous
	Pierre Shale		Upper Cretaceous
	Mowry Shale		Upper Cretaceous
	Skull Creek Shale		Lower Cretaceous
	Inyan Kara Group and Morrison Formation		Lower Cretaceous and Upper Jurassic

Sources: Love, J.D., Christiansen, A.C., and L. W. McGrew. 1987.  
Geologic Map of the Newcastle Quadrangle Geological Survey  
of WY Map MS-25I

Love, J.D., Christiansen, A.C., McGrew, L. W. and J.K.  
King. 1990. Geologic Map of the Gillette Quadrangle.  
Map MS-25G

**FIGURE 3.3** GEOLOGIC MODEL FOR THE THUNDER BASIN NATIONAL GRASSLAND  
Cheyenne River Basin and Upton-Osage area.





Tffr	Fort Union Formation	Tongue River Member	Paleocene
Tfl	Fort Union Formation	Lebo Member	Paleocene
Tfil	Fort Union Formation	Tongue River & Lebo Members undivided	Paleocene
Tfs	Fort Union Formation	Tullock Member	Paleocene
KI	Lance Formation		Upper Cretaceous
Kfh	Fox Hills Formation		Upper Cretaceous

Source: Love, J.D., Christensen, A.C., McGrew, L.W. and J.K. King. 1990. Geologic Map of the Gillette 1° by 2° Quadrangle, Northeastern Wyoming and Western South Dakota. Wyoming Geological Survey Map MS-25G

**FIGURE 3.4 GEOLOGY MODEL FOR THE SPRING CREEK UNIT**

State Highway 116 alignment. The other formations all formed under marine conditions during the Cretaceous period. The Fox Hills sandstone is east of the Lance Formation and the rest of the formations in the Upton-Osage Area are marine shales, many of which contain bentonite beds.

Erosion of geologic substrates depends on their position in the watershed. Where soft shales and claystones are drained by streams with a steep gradient to the baselevel stream (such as the Cow Creek Buttes or Spring Creek areas), badlands with considerable relief form and soils will be shallow or nonexistent. Where resistant sandstones are present, buttes, escarpments or plateaus may form (Miller Hills, Rochelle Hills, Duck Creek area).

The depositional environments of the millenia from the lower Cretaceous period to the Eocene Epoch produced a wide array of substrates. The modern landscape formed from erosion of these substrates is complex. The patterns of homogeneity and patchiness in these geologic substrates create the framework for contemporary biological diversity. Oil and gas plays are located in older formations 5000 to 7000 feet below the present landscape. The patterns of oil and gas occurrence in these formations bear no relationship to the surface geology, vegetation or other patterns of biological diversity.

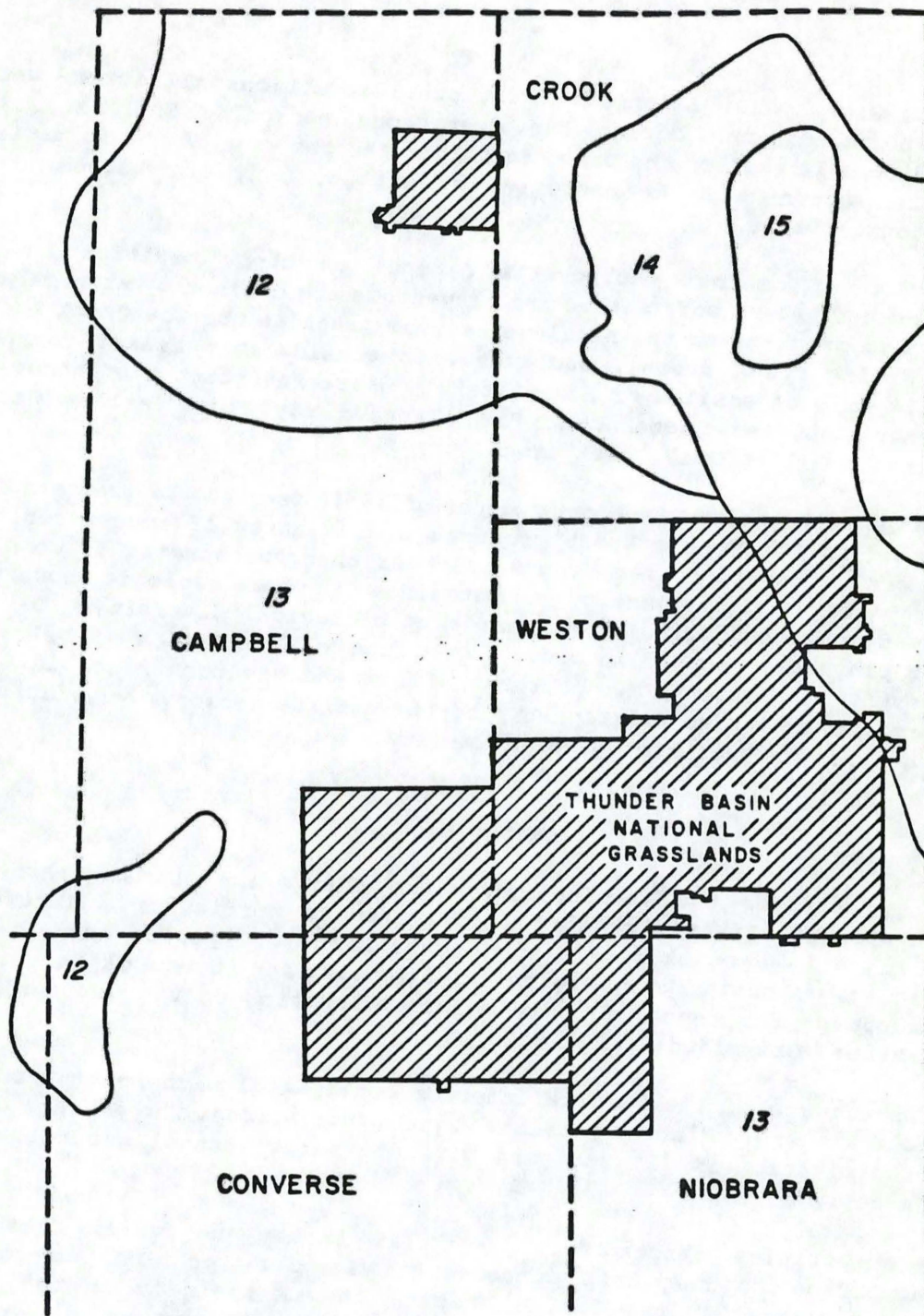
#### **Climatic setting**

Climate forms the envelope in which plants and animals carry out physiological activity that allows them to persist in a landscape. Climate is a major constraint on the kinds of species and types of landscapes that make up biological diversity and it is a major limiting factor on the range of choices for reclamation on the Thunder Basin National Grassland.

The climate of the TBNG is interior continental with hot summers and cold winters. Wind is persistent and often strong. The average annual precipitation is 12" per year with an average annual snowfall of 40 inches.

Precipitation ranges from 10 to 19 inches per year, classified according to the Soil Conservation Service Technical Range site descriptions (Figure 3.5). Most of the CR Basin is in the 10-14" Northern Plains Precipitation Zone; the Spring Creek area is in the 15-17" Northern Plains Zone and a small part of the U-O area is in the 15-19" Black Hills Zone. Table 3.1 contains climate profiles comparing climate statistics for the Spring Creek Area (Gillette 2E), the Cheyenne River Basin (Dull Center) and Upton for the period 1951-1980.

Summarized statistics only provide information on means, ranges, or totals. Differences in pattern of precipitation distribution through the year in relation to temperature can be seen in climate diagrams for the Gillette, Upton and Dull Center stations in Figure 3.6. Patterns of spring precipitation are similar for all three areas, with the main difference being in the amount of snow received in the Spring Creek



Site	Description
12	15" - 17" Northern Plains
13	10" - 14" Northern Plains
14	15" - 19" Black Hills
15	20" - 24" Black Hills

Source: USDA Soil Conservation Service. 1988. Technical Range Site Guide - Northern Plains

**FIGURE 3.5 TECHNICAL RANGE SITE PRECIPITATION ZONES**

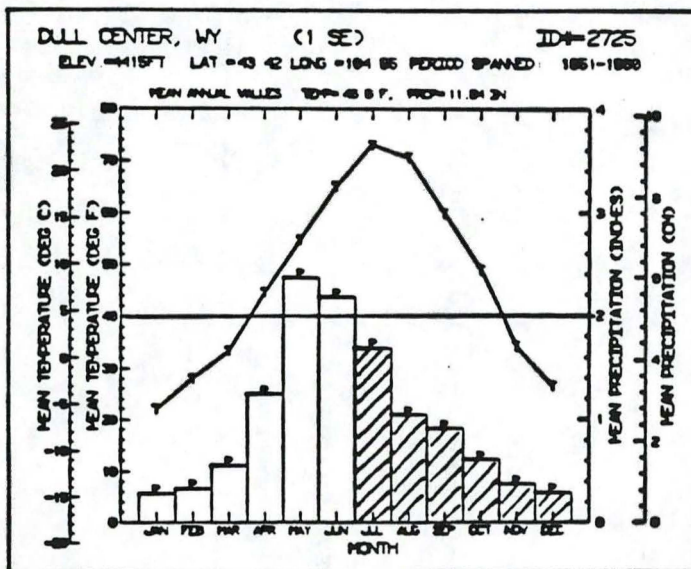
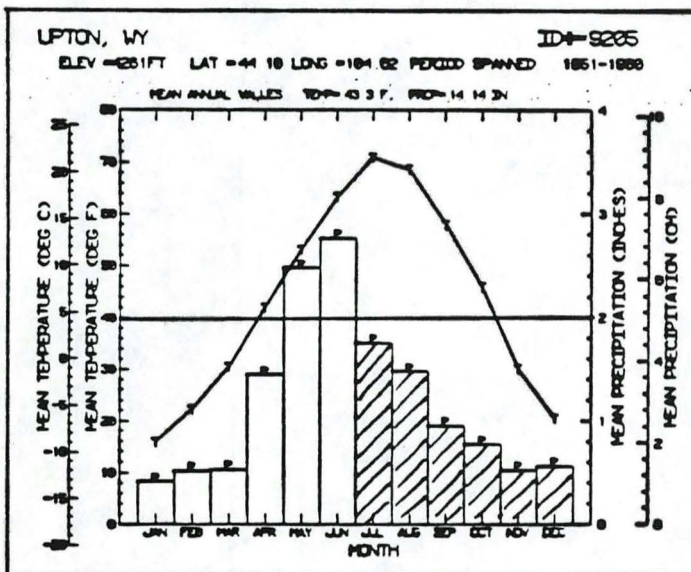
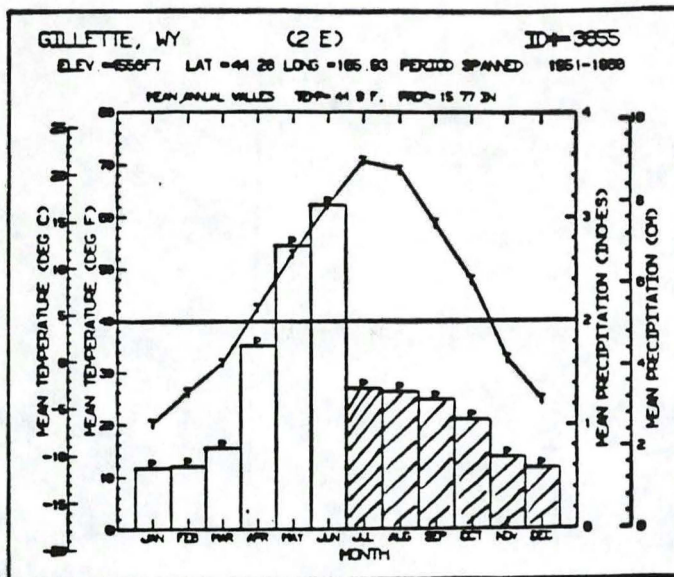


FIGURE 3.6 CLIMATOGRAMS  
 FOR THE THUNDER BASIN  
 NATIONAL GRASSLAND  
 (Martner, 1986)

**TABLE 3.1 CLIMATE PROFILE FOR THE THUNDER BASIN NATIONAL GRASSLAND**

	<b>Spring Creek Area (Gillette 2E)</b>	<b>Northeastern Area (Upton)</b>	<b>Central Area (Dull Center)</b>
<b>Mean annual temperature (°F)</b>	<b>44.9°</b>	<b>43.3°</b>	<b>46.6°</b>
<b>Highest temperature</b>	<b>104°</b>	<b>110°</b>	<b>109°</b>
<b>Lowest temperature</b>	<b>-34°</b>	<b>-42°</b>	<b>-47°</b>
<b># days min temp 32° or less</b>	<b>181</b>	<b>201</b>	<b>173</b>
<b>Mean annual precipitation (in)</b>	<b>15.8</b>	<b>14.1</b>	<b>11.8</b>
<b>Mean annual snowfall</b>	<b>63.3</b>	<b>43.5</b>	<b>44.7</b>
<b>Days snowcover 1" or more</b>	<b>85.6</b>	<b>85.5</b>	<b>54.8</b>

**From: Martner, B. 1986. Wyoming Climate Atlas**

area as compared to Dull Center. The July-December patterns for Spring Creek differ sharply from Upton and Dull Center, due to the much steeper drop in monthly precipitation from June to July than the areas farther south and east. This is due to the ability of Gulf moisture to penetrate into the northern Great Plains to produce convectional storms in the summer.

### **Soils**

Soil surveys have been completed for Northern Converse and Weston Counties. Soil Surveys are in progress for Campbell County. Nearly 100 Soil Series have been identified from the completed surveys. Aridisols and Entisols have the greatest number of Series, followed by Mollisols, Alfisols and Inceptisols. Soils patterns are very complex and soil-vegetation correlations are limited. A list of Soil Orders and Soil Series in in Table 3 of the Appendix.

## **VEGETATION BIOLOGICAL DIVERSITY**

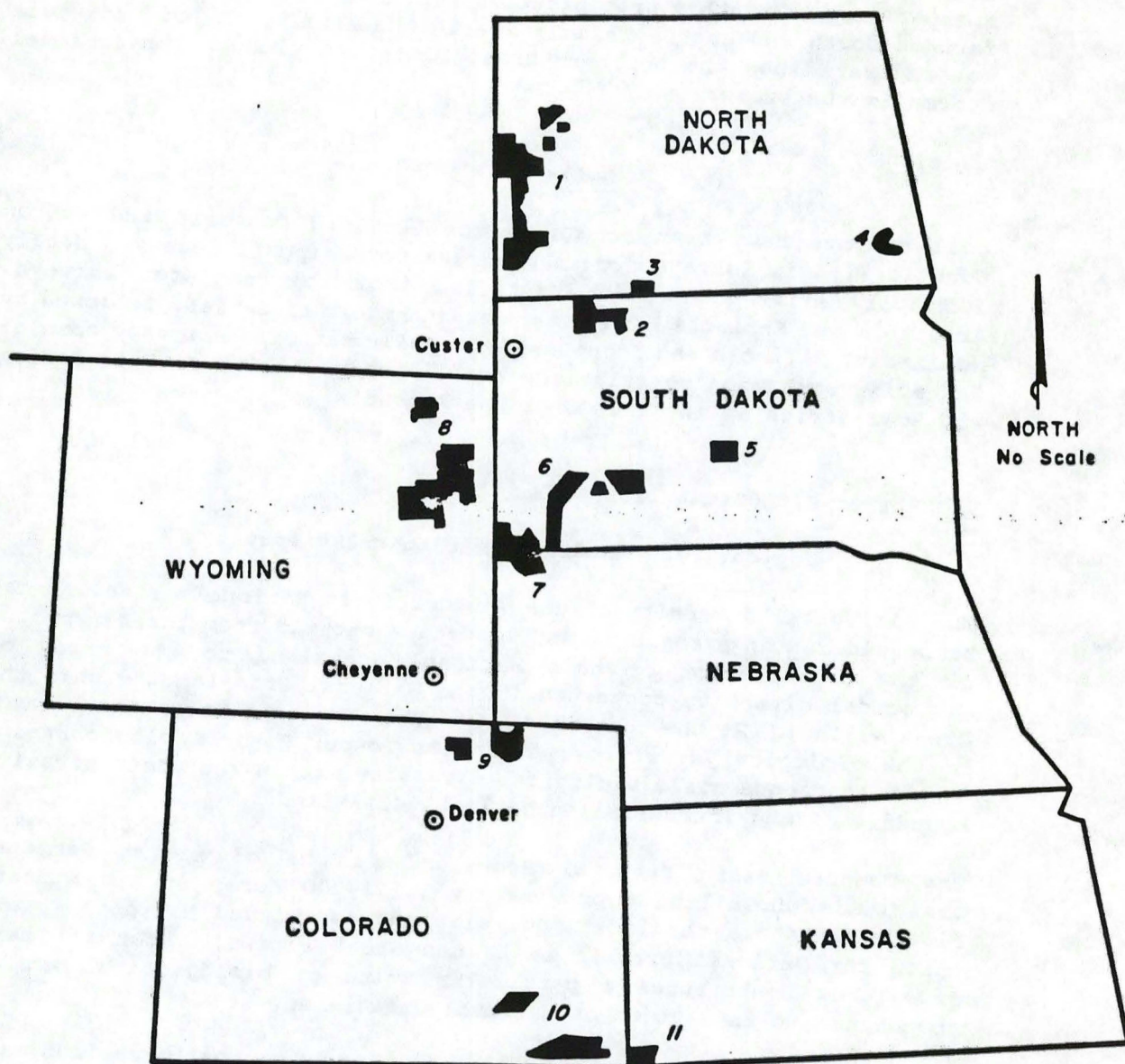
### **Regional and Landscape Biological Diversity**

The biological diversity of the Thunder Basin National Grassland can be considered in a regional and landscape setting from three aspects: 1. the contribution of this National Grassland to the array of biological diversity contained in the National Grasslands within the Great Plains; 2. the contribution of this National Grassland acreage to the biological diversity within the Powder River Geologic Basin; 3. the landscape scale biological diversity within the administrative boundary of the Thunder Basin National Grassland.

The Thunder Basin National Grassland is one of eleven National Grasslands, totalling approximately 3,371,700 acres in six states. Figure 3.7 shows the locations, size and associated National Forest units for National Grasslands in the Great Plains. Each of these grasslands contributes a particular suite of biological diversity components to the system of National Grasslands.

The Thunder Basin National Grassland is the westernmost grassland unit in the Great Plains. It is in the broad transition area from the plains of the central United States to the basin and range physiographic provinces to the west. The other Great Plains National Grasslands are located on mostly Paleozoic and Mesozoic substrates. Thunder Basin National Grassland is on younger rocks (Paleocene and Eocene).

Floristically the TBNG occupies a north-south transition area between the southern and middle Rocky Mountains. Because of this location, populations of plants characteristic of the Black Hills and northern Great Plains (for example hawthorne, big bluestem, little bluestem and creeping juniper) can be found along with plants characteristic of the southern and central Great Plains (buffalo grass, blue grama, prickly pear cactus) and plants characteristic of the intermountain basins to



Number	Name	Acres	Associated National Forest Unit
1	Little Missouri	1,028,000	Custer National Forest
2	Grand River	155,000	Custer National Forest
3	Cedar River	6,700	Custer National Forest
4	Sheyenne	71,000	Custer National Forest
5	Fort Pierre	116,000	Nebraska National Forest
6	Buffalo Gap	591,000	Nebraska National Forest
7	Ogalala	94,000	Nebraska National Forest
8	Thunder Basin	572,000	Medicine Bow National Forest
9	Pawnee	193,000	Arapaho-Roosevelt National Forest
10	Comanche	437,000	Pike-San Isabel National Forest
11	Cimarron	108,000	Pike San Isabel
Approximate Total Acres		3,371,700 in 6 states	

(There are a total of 20 National Grasslands in other states, including Oklahoma (1); Texas (4); New Mexico (1); Oregon (1); Idaho (1) California (1)).

**FIGURE 3.7 NATIONAL GRASSLANDS IN THE CENTRAL AND NORTHERN GREAT PLAINS**

the west (greasewood, bluebunch wheatgrass). Foothill and lower elevation mountain species are also found in this landscape (ponderosa pine, Rocky Mountain juniper, oregon grape, boxelder).

The Thunder Basin National Grassland is at or near range limits for many species of plants and it also supports populations of disjunct species. The biological diversity of the Thunder Basin National Grassland is enhanced because of the floristic variety present due to the range limits and disjuncts. The diversity of floristic composition is shown in Table 3.3. Elements of Northwestern Ponderosa Forest, Eastern Ponderosa Forest, Black Hills Pine Forest, Juniper-steppe woodland, Plains Grassland, Palouse Prairie, Cold Desert Shrublands, Mountain and Foothills Mixed Shrublands and numerous riparian types are represented in the floristic biological diversity of the Thunder Basin National Grassland.

Scoria buttes, sandstone outcrops and badlands, which comprise a part of the 572,000 acres of Federal Land are important special habitat patches within the matrix of Paleocene, Eocene and Pleistocene sediments which form the landscape of this National Grassland. The Miller Hills area is the southernmost extent of scoria in the Great Plains. These landscape patches form small islands which are very important elements in the biological diversity of the Thunder Basin National Grassland. These patches contain remnant populations of woody perennial plants and substrates that restrict plant and animal species composition.

The Upton-Osage area is in the transition area (ecotone) between the Black Hills forests and the grassland and shrub-steppe of the Powder River Basin. The Spring Creek area is in the transition from the northern part of the Powder River Basin to the Williston Basin in Montana and North and South Dakota. The Thunder Basin National Grassland provides habitat to migratory birds along the Rocky Mountain flyway, including neotropical migrants and other birds which spend summer or winters in eastern Wyoming.

#### **Plant Community Biological Diversity**

The matrix, river corridors, and spatial arrangement of vegetation types forming large scale patches in the Cheyenne River Basin and Upton-Osage Areas of the Thunder Basin National Grassland are shown in Figure 3.8. This map was drawn from an aerial photomosaic and verified by ground observation. The classification is based on Table 3.2 and Table 1 (Appendix) which were developed from vegetation classification studies done by the Rocky Mountain Forest and Range Experiment Station (Thilenius, 1992), and the Region 2 Plant Associations Guide (Johnston, 1987).

The vegetation is classified by physiognomic type (forest, woodland, shrubland, grassland); by landscape position (upland or riparian) and by other descriptors as appropriate (deciduous, coniferous, saline, non-saline). Specific community types (Tables 3.4 and 3.5) are nested within the more general classification framework of physiognomic type/landscape position. Because many streams flow mainly underground

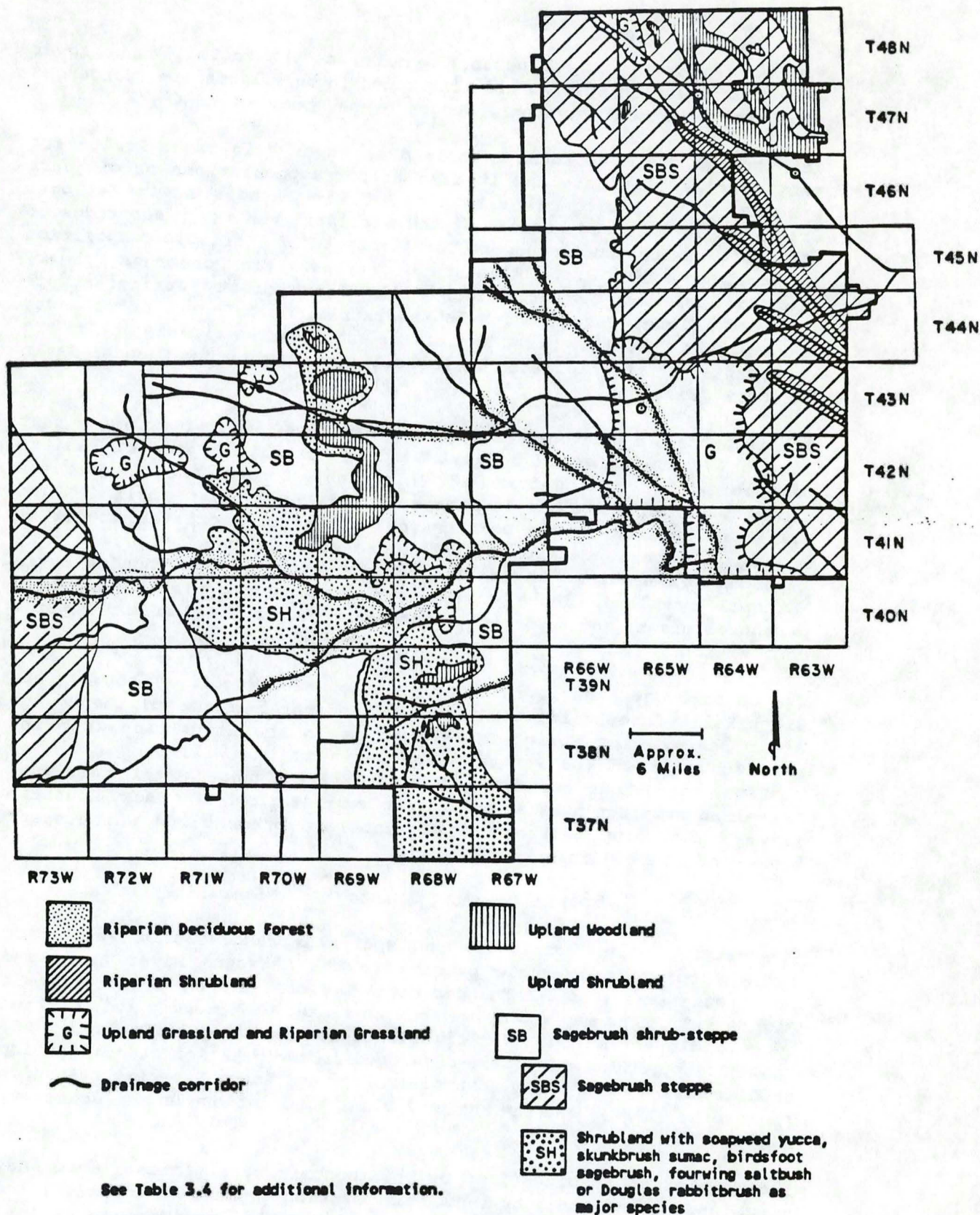


TABLE 3.2

## VEGETATION CLASSIFICATION FOR LARGE MAP UNITS

COMMUNITY  
TYPES\*

## FOREST WOODLAND SHRUBLAND GRASSLAND

## RIPARIAN DECIDUOUS FOREST

1 Plains cottonwood/ western snowberry X

## RIPARIAN WOODLAND

2 chokecherry/snowberry-western wheatgrass\*\*\* X

## UPLAND WOODLAND

3 ponderosa pine/ bluebunch wheatgrass X

4 ponderosa pine/ Rocky Mountain juniper X

5 Rocky Mountain juniper X

## RIPARIAN SHRUBLAND

(non-saline)

6 silver sagebrush/ blue grama X

7 silver sagebrush/ blue grama-prairie sandreed X

(saline)

8 black greasewood/ western wheatgrass-blue grama X

## UPLAND SHRUBLAND

(Shrubland)

9 birdfoot sagebrush X

10 fourwing saltbush X

11 Douglas rabbitbrush X

(Shrub-steppe)

12 skunkbrush sumac/ bluebunch wheatgrass X

13 soapweed yucca/ needleandthread X

14 big sagebrush/ bluebunch wheatgrass X

15 big sagebrush/ blue grama-bluebunch wheatgrass X

16 big sagebrush/ green needlegrass\*\* X

17 big sagebrush/ western wheatgrass\*\* X

18 big sagebrush/ blue grama-western wheatgrass\*\* X

## RIPARIAN GRASSLAND (non-saline)

19 western wheatgrass X

## UPLAND GRASSLAND

20 little bluestem X

21 blue grama X

22 blue grama-threadleaf sedge X

23 needleandthread/ blue grama X

\*Community Types from Thilenius, J. and G. Brown. 1992. Vegetation on Semi-Arid Rangelands, Cheyenne River Basin, Wyoming. Manuscript in Preparation. USDA Forest Service, Laramie, WY

\*\* These three community types also occur as shrub steppe, where sagebrush occurs as the dominante cover species In steppe communities, grasses and sedges form the predominant cover type.

\*\*\*From: Johnston, B.C. 1987. Plant Associations of Region 2. R2-ECOL-87-2 Denver, Colorado USFS

**TABLE 3.3 VEGETATION CLASSIFICATION OF THE THUNDER BASIN NATIONAL GRASSLAND ACCORDING TO THE REGION 2 HIERARCHY (Johnston, 1987). (Units applicable to the Thunder Basin National Grassland).**

---

- I. PLAINS GRASSLAND FORMATION**
    - 01. Tallgrass Prairie
      - B. Bluestem Prairie
    - 02. Northern Mixed-grass (Midgrass) Prairie
      - A. Wheatgrass-Needlegrass
      - B. Bluestem-Grama Prairie
      - C. Wheatgrass-Bluestem Prairie
    - 03. Shortgrass Prairie
      - A. Grama-Needlegrass-Wheatgrass
      - B. Grama-Buffalograss
  - II. PLAINS RIPARIAN, FLOODPLAIN, AND OTHER WATER-DOMINATED COMMUNITIES**
    - 05. Fresh-Water Riparian Grasslands
    - 06. Salt Flats
    - 07. Plains Deciduous Woody Riparian
      - A. Plains Cottonwood
      - B. Ash-Elm-Maple Bottoms
  - III. FOOTHILL AND MOUNTAIN GRASSLANDS**
    - 08. Palouse Prairie
      - A. Fescue-Wheatgrass
      - B. Wheatgrass-Bluegrass
      - C. Foothills Prairie
  - IV. WOODLAND**
    - 12. Coniferous woodland
      - B. Juniper-steppe woodland
  - V. COLD DESERT SHRUBLAND**
    - 14. Desert alluvial salt-shrub
      - A. Saltbush and shadscale
      - B. Greasewood
    - 15. Sagebrush
      - B. Basin Big Sagebrush
      - C. Mountain and Eastern Foothills Sagebrush
  - VI. MOUNTAIN AND FOOTHILLS MIXED SHRUBLAND**
    - 16. Deciduous Green shrubland
      - B. Serviceberry and Chokecherry
      - C. Snowberry
  - VII. MOUNTAIN CONIFEROUS FORESTS**
    - 19. Foothills and Plains Coniferous Forests
      - A. Eastern Ponderosa Forest
      - B. Black Hills Pine Forest
    - 20. Montane Coniferous Forest
      - A. Northwestern Ponderosa Forest
-

in this high plains environment, riparian areas as differentiated from uplands on the map, may include deciduous forests, shrublands or grasslands which exist because of supplemental water because of topographic position and seeps.

The vegetation is classified as follows for the purpose of the large-scale map:

#### **Upland Areas**

Upland Woodlands (ponderosa pine, juniper, ponderosa pine and juniper)

#### **Upland Shrubland**

Shrubland - birdsfoot sagebrush, four-wing saltbush, Douglas rabbitbrush, skunkbrush sumac)

\*Sagebrush shrub-steppe (sagebrush predominates with grass patches or corridors)

\*Sagebrush steppe (grass predominates with sagebrush patches or corridors)

\*Upland Grassland (blue grama, little bluestem, threadleaf sedge and needleandthread)

#### **Riparian Areas**

Riparian deciduous forest (plains cottonwood)

Riparian Woodland (woody draws - boxelder, hawthorne, chokecherry)

Riparian Shrubland (black greasewood, silver sagebrush)

Riparian Grassland (playas)

\* Sagebrush shrub-steppe, sagebrush steppe and upland grassland are the vegetation types which comprise the matrix of the TBNG landscape. This may also be called sagebrush-grassland.

Summarized characteristic plant species and plant species richness by physiognomic type for part of the Cheyenne River Basin are in Table 3.4 and 3.5.

The community types listed in Table 3.4 (with the exception of those in the Riparian Deciduous Woodland category) are based on field studies where plant species composition and cover was measured at many sites in the coal-bearing area of the Cheyenne River Basin (Thilenius, 1992). Additional community types characteristic of smaller patches or of the Upton-Osage and Spring Creek areas, which were not included in the field work for the Cheyenne River Basin (Thilenius, 1992) are listed in Table 3.6 and Table 2 (Appendix). These are described in the literature and summarized in Johnston (1987). A different broad-scale vegetation classification system for the entire eastern Powder River Basin was presented in the FEIS for proposed coal development (Eastern Powder River Basin FEIS, 1974).

The matrix of the Cheyenne River Basin and Upton-Osage portions of the Thunder Basin National Grassland consists of a shrubland and grassland vegetation containing sagebrush steppe, sagebrush shrub-steppe and upland grassland. Sagebrush shrub-steppe (where sagebrush forms a dense cover and grass patches and corridors are subordinate, or

**TABLE 3.4 CHARACTERISTIC VASCULAR PLANT SPECIES OF THE CHEYENNE RIVER BASIN**

Physiognomic Type	Common Name	Scientific Name
Trees	eastern cottonwood	<i>Populus deltoides</i>
	ponderosa pine	<i>Pinus ponderosa</i>
	rocky mountain juniper	<i>Juniperus scopulorum</i>
Shrubs	big sagebrush	<i>Artemisia tridentata</i>
	silver sagebrush	<i>Artemisia cana</i>
	soapweed yucca	<i>Yucca glauca</i>
	Douglas rabbitbrush	<i>Chrysothamnus viscidiflorus</i>
	fourwing saltbush	<i>Atriplex canescens</i>
	birdfoot sagebrush	<i>Artemisia pedatifida</i>
	skunkbrush sumac	<i>Rhus trilobata</i>
	black greasewood	<i>Sarcobatus vermiculatus</i>
Grasses & Sedges	western snowberry	<i>Symphoricarpos occidentalis</i>
	blue grama	<i>Bouteloua gracilis</i>
	western wheatgrass	<i>Pascopyrum smithii</i>
	needleandthread	<i>Stipa comata</i>
	prairie sandreed	<i>Calamovilfa longifolia</i>
	little bluestem	<i>Schizachyrium scoparium</i>
	green needlegrass	<i>Stipa viridula</i>
	threadleaf sedge	<i>Carex filifolia</i>

From Thilenius (1992). Scientific names have been updated to correspond to the Plant List of Accepted Nomenclature, Taxonomy and Symbols, January, 1992 USDA-SCS.

**TABLE 3.5 VASCULAR PLANT SPECIES RICHNESS BY PHYSIOGNOMIC TYPE FOR THE COAL-BEARING REGION OF THE CHEYENNE RIVER BASIN**

Physiognomic Type	Number of species
Trees	
Deciduous trees	1
Coniferous trees	2
Shrubs	18
Forbs	123
Graminoids	37
(grasses, sedges, rushes)	
Total	181

This list is from Thilenius (1992) and applies to the area surveyed within Cheyenne River Basin for the classification study. Additional species are found in the Spring Creek Unit and in the Upton-Osage areas, but there is not specific documentation for plant species in these areas. Additional species not documented in the survey may also be found on the Thunder Basin National Grassland.

TABLE 3.6

## ADDITIONAL VEGETATION CLASSIFICATION UNITS

The vegetation types listed below were listed for the Thunder Basin National Grassland in Johnston (1987) or noted by Douglas District Staff. In contrast to the Thilenius (1992) classification, no direct quantitative measurements were made for these types on the Thunder Basin National Grassland described from other areas. Many of these are closely related to the 22 major types described for the Cheyenne River Basin by Thilenius, but the list also includes some which are found in the Spring Creek or Upton-Sage areas which were outside of the Thilenius collection area in the central Cheyenne River Basin. They may occupy smaller patches than the community types listed in Table 3.3. Those marked with an asterisk are the same or similar to the major types described in the Thilenius classification which was used for the large map units. Thilenius includes patches of grasses within sagebrush areas containing mixtures of western wheatgrass, blue grama, green needlegrass, needleandthread and threadleaf sedge within the sagebrush shrub-steppe or sagebrush steppe mosaics. The Johnston classification places grass or grass-sedge patches in a grassland category.

COMMUNITY  
TYPES

## FOREST WOODLAND SHRUBLAND GRASSLAND

## RIPARIAN DECIDUOUS FOREST

- 1 Plains cottonwood/western snowberry-basin wildrye\* X

## RIPARIAN DECIDUOUS WOODLAND

- 2 green ash/chokecherry X  
3 chokecherry-snowberry/ western wheatgrass X  
4 aspen/ oregongrape X

## UPLAND CONIFEROUS WOODLAND

- 5 ponderosa pine/ bluebunch wheatgrass\* X  
6 ponderosa pine/ sun sedge\* X  
7 ponderosa pine/ little bluestem\* X  
8 Rocky Mountain juniper/ western wheatgrass\* X  
9 Rocky Mountain juniper/ bluebunch wheatgrass\* X

## RIPARIAN DECIDUOUS SHRUBLAND

- 10 silver sagebrush/ western wheatgrass\* X  
11 black greasewood-big sagebrush/western wheatgrass\* X  
12 black greasewood/ alkali sacaton\* X  
13 black greasewood-fourwing saltbush/ sandberg bluegrass\* X

## UPLAND DECIDUOUS SHRUBLAND

- (steppe and shrub-steppe)  
14 big sagebrush/ western wheatgrass\* X  
15 big sagebrush/ needleandthread\* X  
16 big sagebrush/ bluebunch wheatgrass\* X

## RIPARIAN GRASSLAND

- (non-saline)  
17 western wheatgrass/ needle spikesedge X  
18 American bulrush/ sedge spp X  
(saline)  
19 inland saltgrass/ Nuttall alkaligrass X  
20 inland saltgrass/ western wheatgrass X  
21 inland saltgrass/ alkali sacaton-western wheatgrass X

## UPLAND GRASSLAND\*\*

- 22 big bluestem/ little bluestem X  
23 bluebunch wheatgrass/ sideoats grama X  
24 bluebunch wheatgrass/ blue grama X  
25 bluebunch wheatgrass/ threadleaf sedge X  
26 bluebunch wheatgrass/ western wheatgrass X  
27 blue grama/ needleandthread\* X  
28 blue grama/ western wheatgrass\* X  
29 blue grama/ winterfat X  
30 blue grama/ needleleaf sedge\* X  
31 blue grama/ sun sedge X  
32 blue grama/ buffalograss X  
33 little bluestem/ blue grama\* X  
34 little bluestem/ sideoats grama\* X  
35 needleandthread/ blue grama X  
36 plains muhly/ little bluestem X  
37 western wheatgrass/ blue grama\* X

\*\* most of these are included in the sagebrush shrub-steppe or sagebrush steppe by the Thilenius classification (1992)

sagebrush steppe (where grass is dominant and sagebrush forms patches or follows depression contours) covers about 70% of the area within the administrative boundary of the Cheyenne River Basin and Upton-Osage area. This vegetation is found on uplands which are rolling or slightly dissected (Figures 3.9 and 3.10). The sagebrush vegetation forms a mosaic with grasslands where sagebrush is absent or of very minor importance. Within this matrix are patches of other kinds of shrublands and woodland. The matrix can also be called sagebrush-grassland.

The second largest general type of vegetation in the Cheyenne River Basin and Upton-Osage Areas is upland shrubland containing shrubs such as birdsfoot sagebrush, yucca, Douglas rabbitbrush or fourwing saltbush, with sparse grass or forb understories. Patches of sagebrush communities form a mosaic with these other upland shrubland communities. These mixed shrublands form large patches on about 10% of the Cheyenne River Basin and Upton-Osage areas area along the upper tributaries of the Cheyenne River, east and north of the Rochelle Hills and in the Cow Creek area. Shrublands occur on dissected, eroding substrates of claystone, shale, siltstone and sandstone, of the Tongue River and Lebo members of the Fort Union Formation or in association with scoria outcrops. (Figures 3.11 - 3.20).

Upland grasslands (in which sagebrush or other shrubs are absent or of minor occurrence) are found in the northwestern portion of the Wasatch Formation in association with numerous playas; in restricted flat former floodplain areas near the Cheyenne River, east of the Rochelle Hills, and on the Lance Creek formation south of Highway 450 in the east central area. Grasslands on these surfaces contain mostly blue grama, threadleaf sedge, and needleand thread. Grasslands with little bluestem are found in the Spring-Creek and Upton-Osage areas. Upland grasslands occupy about 10% of the area within the administrative boundary (Figures 3.21-3.24).

Patches of woodlands, which consist of ponderosa pine and/or juniper, occur on another 5% of the area within the Cheyenne River Basin and Upton-Osage area. These are associated with sandstone or scoria in the central part of the Cheyenne River Basin, and with sandstone, limestone and shale in the Upton-Osage Area. The woodlands are islands in the central part of the Cheyenne River Basin, but are peninsulas extending from the Black Hills in the Upton-Osage area. In the Spring Creek area, woodlands are found on about 20% of the area within the administrative boundary (Figures 3.25 - 3.28).

Corridors of deciduous riparian forest or deciduous riparian shrubland occupy about 5% of the area in the Cheyenne River Basin and Upton-Osage area. Riparian corridors are shown in Figure 3.29. Below the confluence of Antelope Creek and the Dry Fork of the Cheyenne River, the floodplain is wide, and gallery forests begin to develop. Along the eastern third of the river, the cottonwood riparian forest is well developed and stringers extend up Lodgepole Creek and Black Thunder Creek. Upstream areas of all the major tributaries of the Cheyenne River have relictual populations of old cottonwood trees. Figure 3.29



Fig. 3.9 Sagebrush shrub-steppe. Much of the matrix in the Cheyenne River Basin consists of sagebrush shrub-steppe. Tall, dense sagebrush develops in the absence of fire. Fire history, herbicide application, soil type and past land-uses such as farming, stocking levels and season of use affect the highly variable development of sagebrush density. 10/10/92 Western Cheyenne River Basin



Fig. 3.10 Sagebrush-steppe characterizes most of the eastern portion of the Cheyenne River Basin. Big sagebrush is smaller and forms discreet patches on uplands or along shallow drainages. This condition of sagebrush appears to be influenced by soil type, fire frequency and management. In some areas this appears to be seral to shrub-steppe, in others it appears to be very stable because of soil and climate. 10/10/92 Eastern Cheyenne River Basin

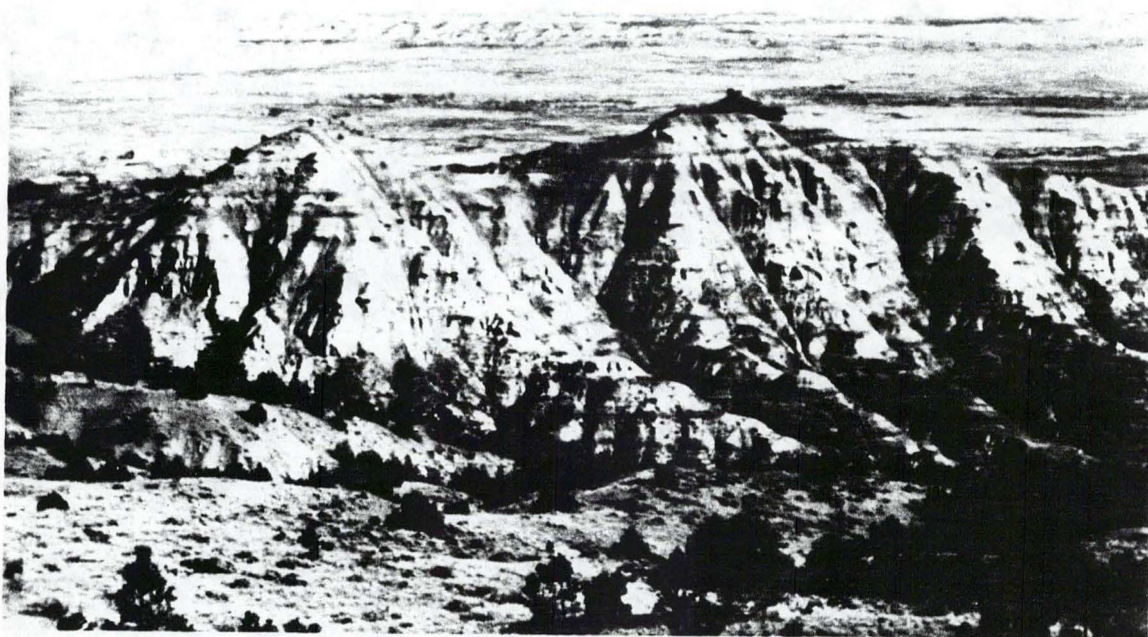


Fig. 3.11 Shrublands and woodlands in the Spring Creek Unit. Eroding members of the Fort Union Formation form high-relief badlands visible in the foreground and background. Shrubs colonize most of these areas, and sagebrush-steppe patches form where sediments have accumulated. Juniper woodlands are found in the valleys and along drainages. 10/22/92 west of Weston, WY



Fig. 3.12 These shrublands are in the Cow Creek Buttes area in the southeastern part of the TBNG. Highly erosive claystones, siltstones and shale components of the Lebo member of the Fort Union formation form the substrate for these shrublands. Yucca, fourwing saltbush, and birdsfoot sagebrush communities are found here. 10/10/92 Southeast of Bill, WY

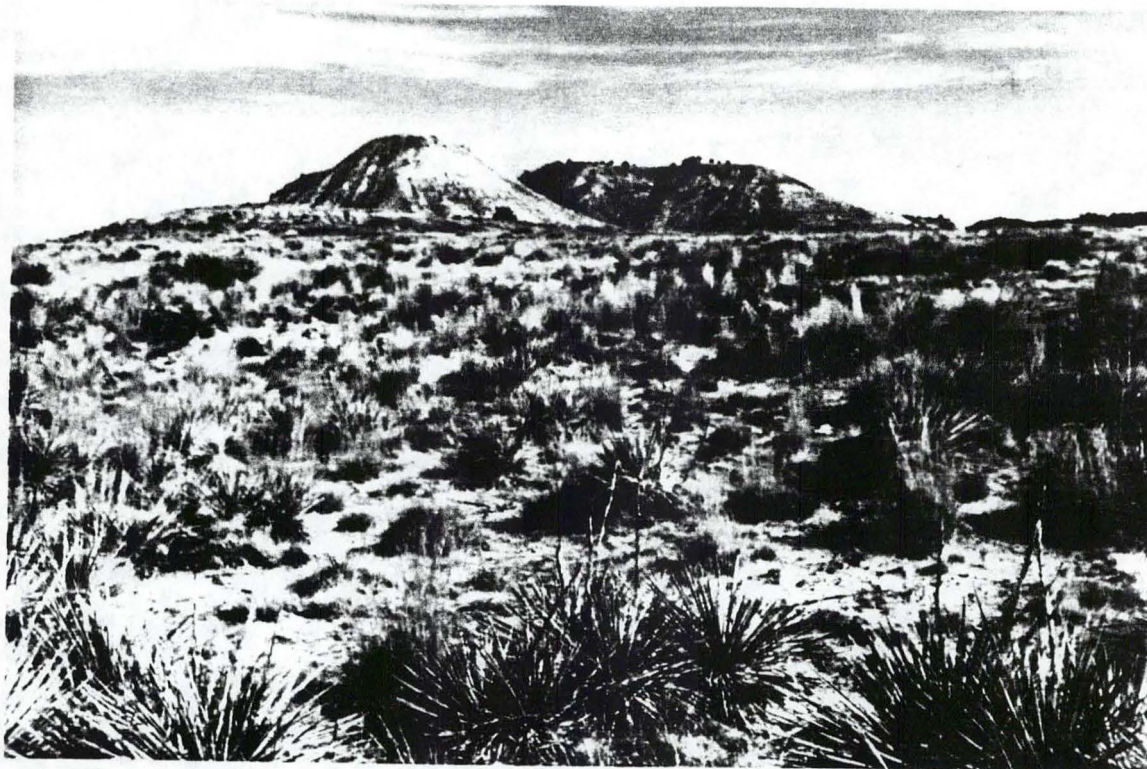


Fig. 3.13 Scoria (porcellanite) forms when sandstone is heated by shallow subsurface coal. Scoria is found from the Miller Hills northward along the contact of the Fort Union and Wasatch Formation. Altered shales, claystones and siltstones are layered with scoria. The Miller Hills area is the southernmost occurrence of scoria in Wyoming. Shrublands with yucca, skunkbrush sumac, and little bluestem associate with scoria. 10/10/92 Miller Hills area.

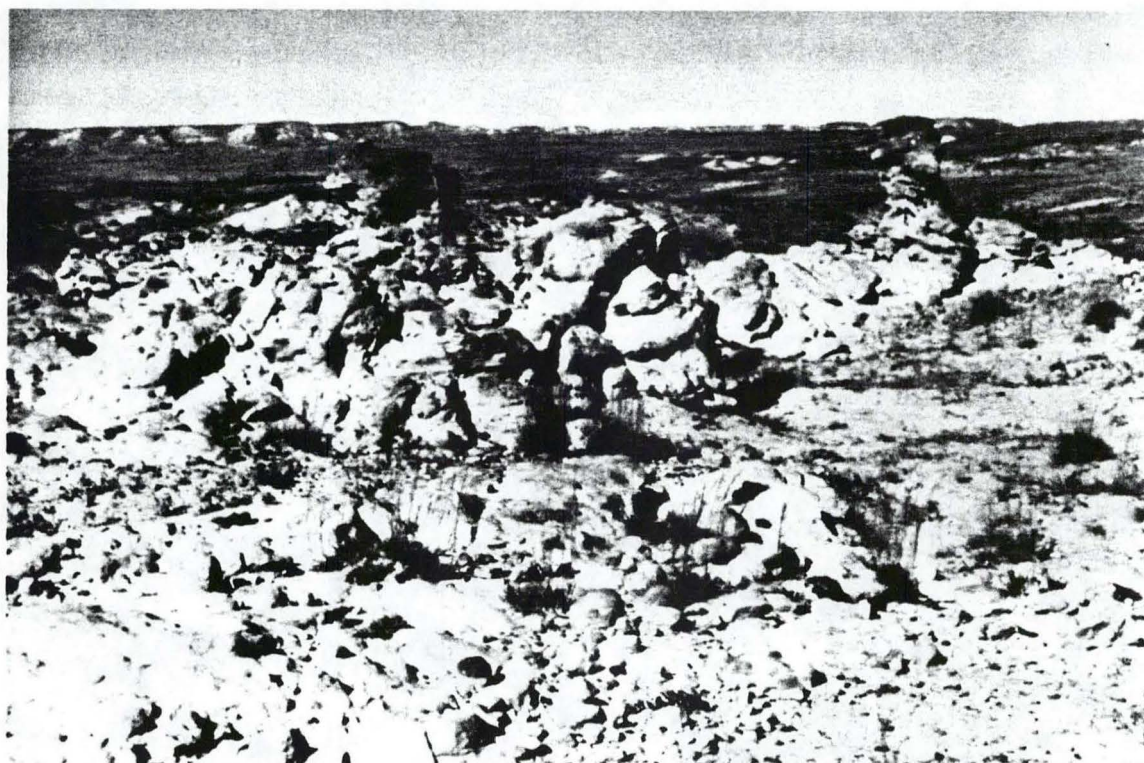


Fig. 3.14 Sandstone erosion forms in the Cheyenne River Valley. The watershed of the Cheyenne River has badlands in some members of the Fort Union Formation. The Cheyenne River is in the midground and the Rochelle Hills escarpment is in the background. 10/22/92 Cheyenne River Basin



Fig. 3.15 Birdsfoot sagebrush shrubland in the Downs area, southeast of Bill and south of Cow Creek Buttes. Birdsfoot sagebrush grows in small patches on flat to gently rolling surfaces. This plant community type provides suitable habitat for mountain plovers because of its vertical structure. 10/10/92. Soouthern end of TBNG.

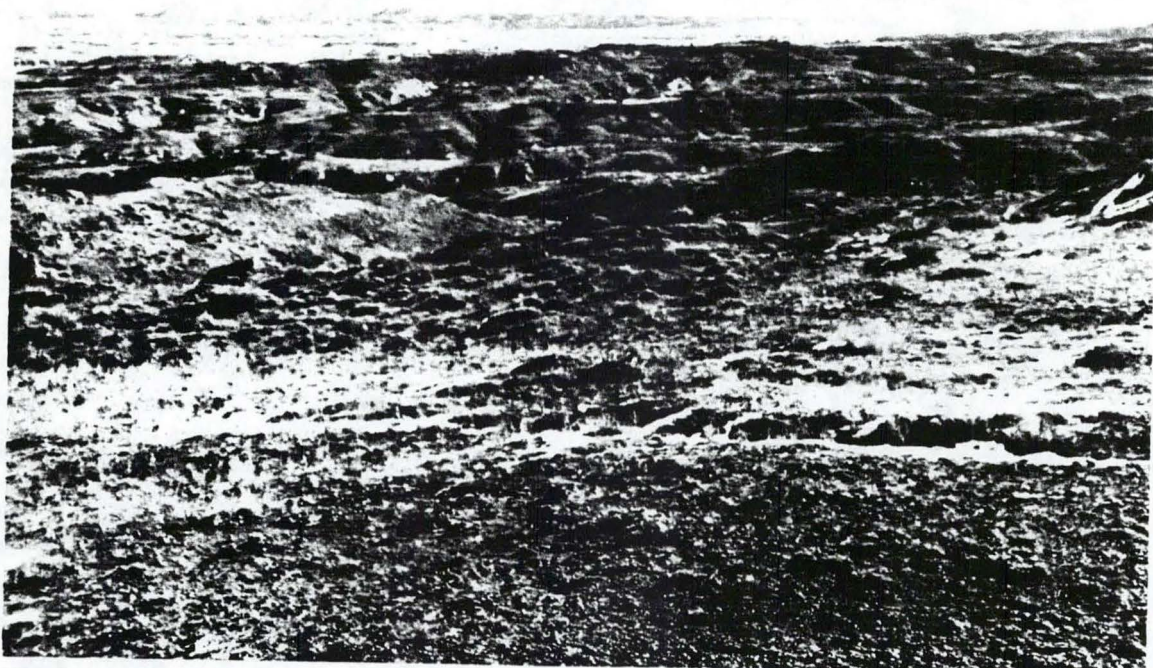


Fig. 3.16 Badlands in the Lebo member (Fort Union Formation) in the Downs area. Cow Creek Buttes are in the background. This is a landscape scale photograph of the same area shown in Figure 3.15. The highly erosive shales, claystones and siltstones today have upland shrubland plant communities. 10/10/92 Southern TBNG.

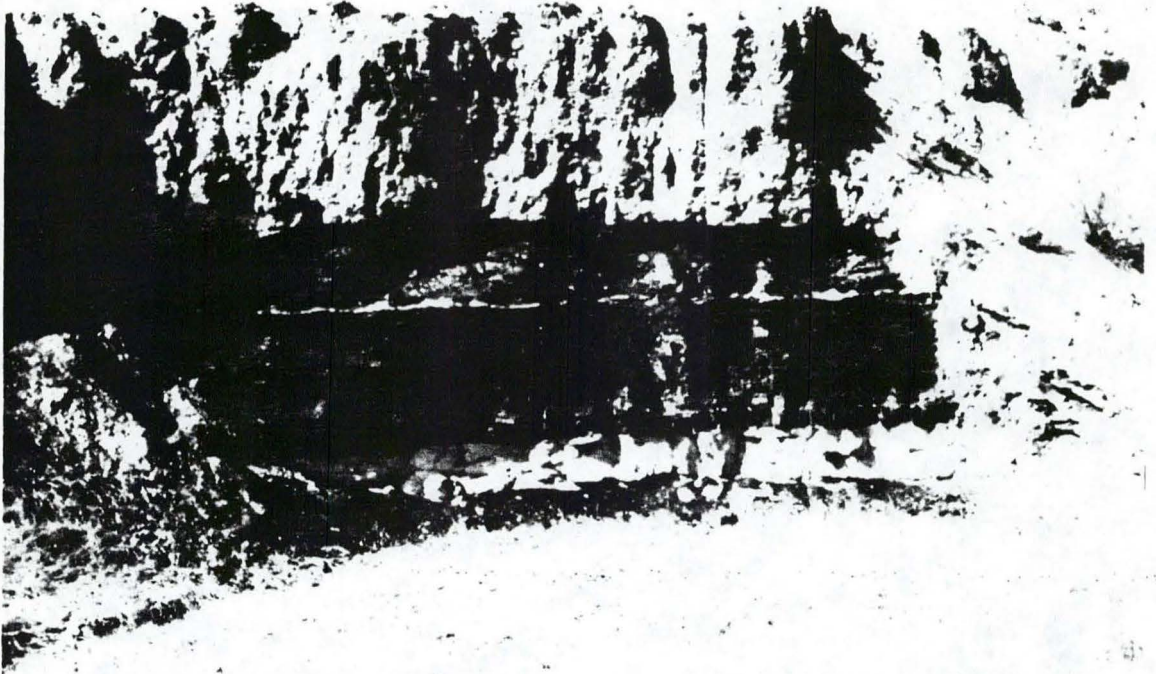


Fig. 3.17 Coal Bank Draw. This is within the Cow Creek Buttes Inventoried Semi-Primitive Area. Thick alluvial deposits overlay the coal, which lies above the white sandstone of the Lebo member. Alluvial deposits such as this underlie relatively flat big sagebrush patches within badlands. 10/10/92 Cow Creek Buttes area.



Fig. 3.18 Yucca and prairie sandreed on a sandy soil patch in the Cow Creek Buttes area. The landscape here has more resistant rocks near the surface and is less dissected. Sagebrush shrub-steppe is highly intermingled with other kinds of upland shrublands. 10/10/92



FIG. 3.19 Scoria landforms in the southern Cheyenne River Basin. Scoria forms a transition between the eroding badlands along Cow Creek and the sandstone/scoria plateau at the crest of the Miller Hills. Ponderosa pine woodland grows on the sandstone, along with little bluestem and bluebunch wheatgrass. 10/10/92 Miller Hills area.



FIG. 3.20 Scoria and sandstone in the Duck Creek Breaks area of the Spring Creek Unit. Scoria and associated communities extends northward into Montana. This valley had a recent fire which removed much of the ponderosa pine woodland. Little bluestem communities are intermingled with sagebrush steppe. Big bluestem and bluebunch wheatgrass are also found here. 10/17/92 Northeastern part of Spring Creek Unit.

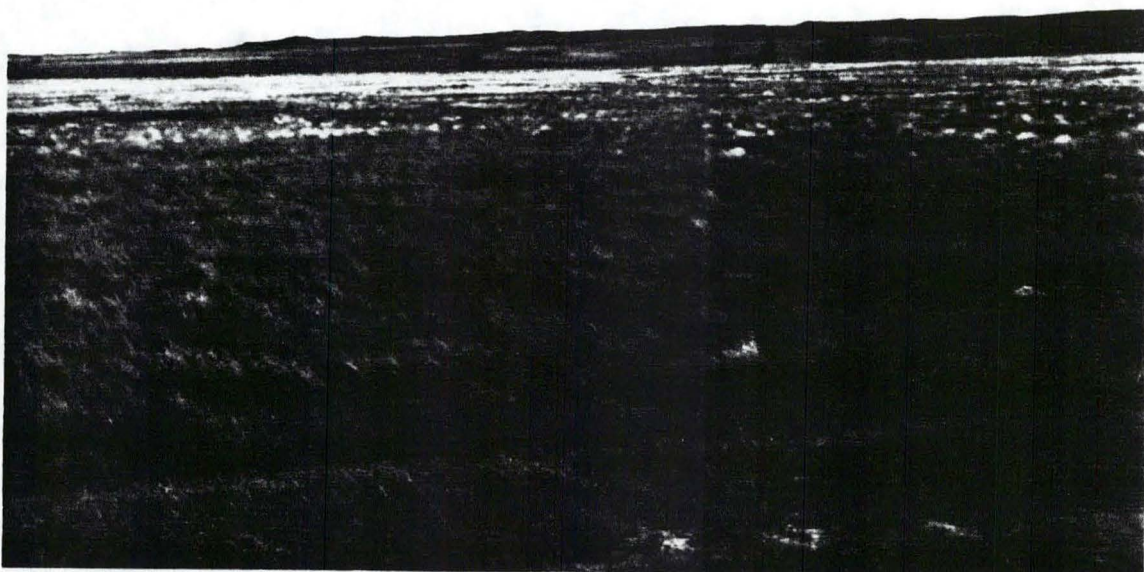


FIG. 3.21 Grassland on the flat plain east of the Rochelle Hills and north of the Cheyenne River. These plains in the Rosecrans area have blue grama sodgrass and lack sagebrush. Many upland grasslands have been farmed, some have high populations of prickly pear cactus, and some have been planted with crested wheatgrass. 10/10/92 Cheyenne River Basin



FIG. 3.22 Prairie dog colony on blue grama grassland community southeast of the Rochelle Hills. 10/10/92 Cheyenne River Basin.



FIG. 3.23 Little bluestem grassland (red color) in York Road area of the Spring Creek Unit. Sagebrush steppe forms patches in the little bluestem grassland. In the distance, a striped pattern, probably from herbicide spraying or blading can be seen in the sagebrush steppe matrix. 10/17/92 Spring Creek Unit.



FIG. 3.24 Riparian shrubland along the Cheyenne River. Foreground is western wheatgrass. Four-wing saltbush and black greasewood have a blue-grama sodgrass understory. Scoria at the south end of the Rochelle Hills is in the background. Riparian shrublands are found on terraces along the Cheyenne River and its larger tributaries. 10/10/92 Cheyenne River Basin



FIG. 3.25 Woodland and sagebrush steppe in the Upon-Osage area. Ponderosa pine-Rocky Mountain juniper woodland grows on shale and limestone, forming a mosaic in the broad ecotone between the Black Hills and the Powder River Geologic Basin. 10/22/92 Upton-Osage area.



FIG. 3.27 Woodland in the Duck Creek Breaks, Spring Creek area. The ponderosa pine woodland here has more canopy cover and less juniper. A few disjunct aspen groves occur in draws. Little bluestem and bluebunch wheatgrass are found in the sagebrush steppe patches; oregon grape is associated with the ponderosa pine and aspen vegetation; big bluestem occurs nearby. 10/22/92 Northeastern part of the Spring Creek Unit.

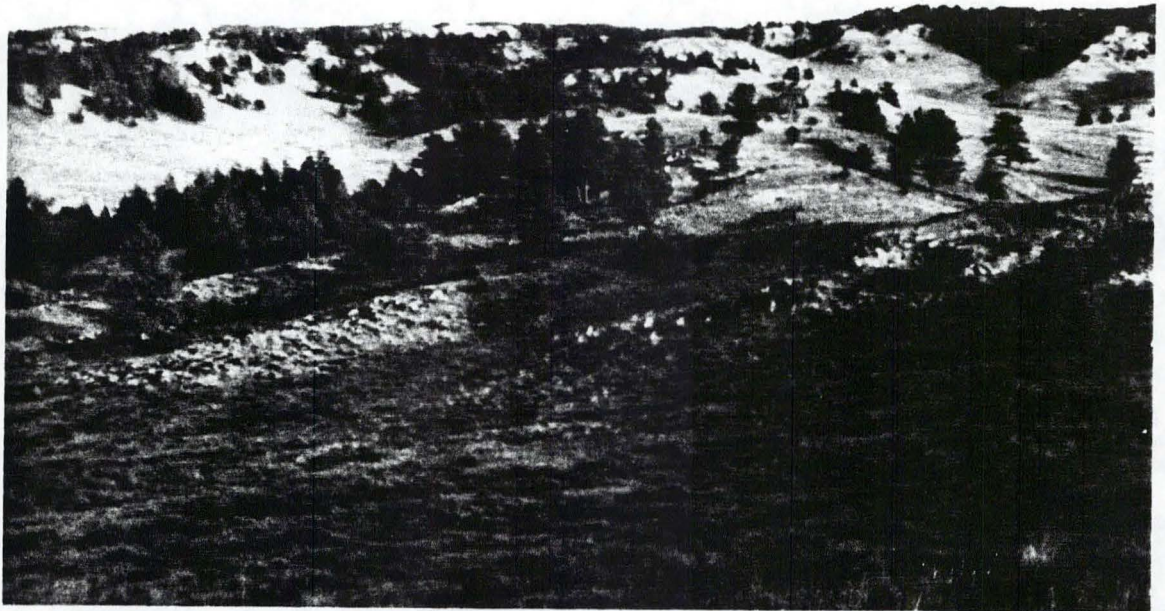


FIG. 3.27 Ponderosa pine woodland on scoria landforms. This woodland is an island in the larger landscape matrix sagebrush - grassland. 10/10/92 North side of scoria outcrops in the Dugout Creek Inventoried Semi-Primitive Area.



FIG. 3.28 Woodland on scoria and sandstone, Miller Hills area. Sandstone-capped buttes of the Cow Creek Buttes area can be seen in the background. 10/10/92

also shows patches where large and/or numerous playas occur, embedded in grassland or sagebrush areas (Figures 3.30 - 3.33).

The landscape vegetation patterns of the Spring Creek Unit are illustrated in Figure 3.34. This landscape has a matrix of sagebrush steppe. Patches of woodland, shrubland and grassland are smaller, more numerous and combined in a more complex way in a smaller area, than in the larger administrative unit to the south, packing many community types into this part of the Thunder Basin National Grassland. The tributaries which head in the Spring Creek area flow into the Little Powder River, whose headwaters are many miles away and whose baselevel creates sharp gradients into the nearby uplands in contrast to the longer, gentler gradients in the Cheyenne River basin. The result is a landscape with substantial elevational differences and topographic diversity.

A special feature of the Spring Creek Unit is the presence of woody draws (classed as Riparian Deciduous Woodland). These draws are at a range limit - similar vegetation is characteristic of North and South Dakota and the Black Hills. A few remnant aspen groves are also found here, adding to the unique biological diversity of the ecotone at the eastern border of the Duck Creek Breaks (Figures 3.35 - 3.37).

Figures 3.37 - 3.40 illustrate some of the forms that patches and corridors may take on the Thunder Basin National Grassland. Woody draws provide important corridors with cover and protection for animal movement. The grassy swales in the Cheyenne River headwaters add biological diversity, especially in a temporal framework when water is seasonally present. Human-created corridors and patches can be seen in the matrix in Figures 3.39 and 3.40.

Migration and the use of corridors on TBNG can be related to the landscape and the local levels. At the landscape level the TBNG is part of the Rocky Mountain Flyway for waterfowl. It also has bird species which migrate to the TBNG for both winter and summer use. Examples of birds migrating to the TBNG are the rough-legged hawk and the bald eagle in the winter, and the mountain plover and ferruginous hawk in the summer. Most of the annual migrations into and out of the TBNG are associated with birds. The rest of the wildlife species stay in the general vicinity of the TBNG. Migrations within the TBNG are related to seasonal movements of big game animals. Mule deer are the only species with a specific winter range. The rest of the big game animals tend to use their range year long.

Corridors within the TBNG may consist of natural or manmade corridors. Natural corridors can be riparian corridors associated with river bottoms; ridges, or stands of vegetation which connect separate habitat sites. Manmade corridors include roads, pipelines, or irrigation canals. These all may link habitats together and be used as travelways.

There is no official list of plant species for the Thunder Basin National Grassland. Thilenius (1992) recorded 181 species of vascular plants from the coal-bearing area of the Cheyenne River Basin used in the classification study. Hartman and Dueholm (1979) prepared a

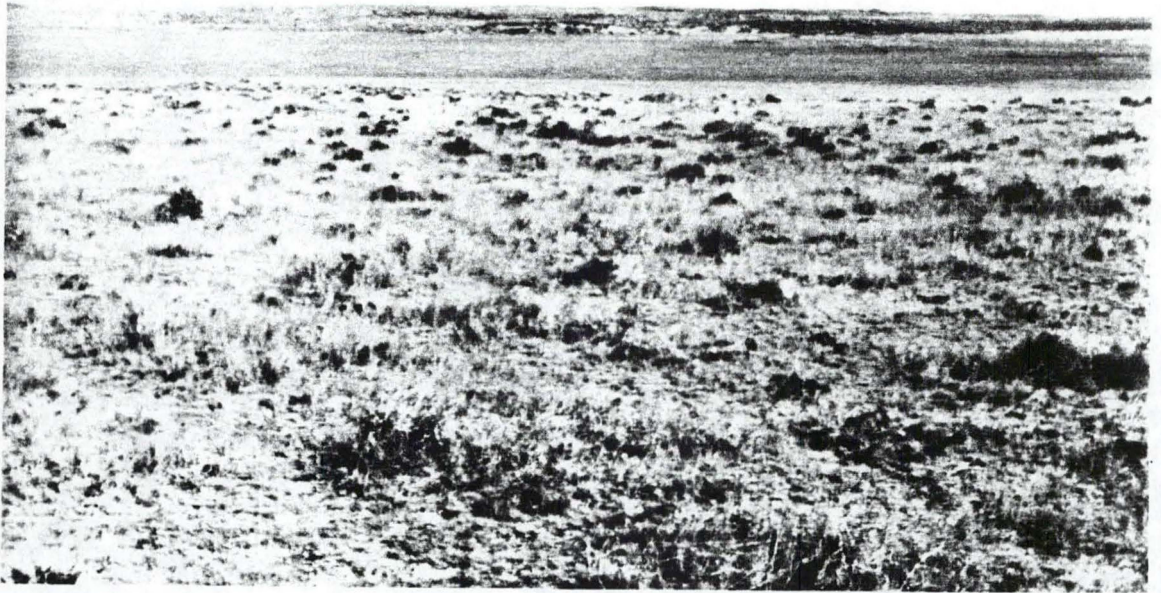


FIG. 3.30 Playas create riparian patches which are seasonally wet. Western wheatgrass is characteristic of playas. They may occur in grassland, sagebrush steppe or sagebrush shrub-steppe. Playa areas are mainly west and south of the Rochelle Hills. 10/22/92 South of the Rochelle Hills and NE of Bill.



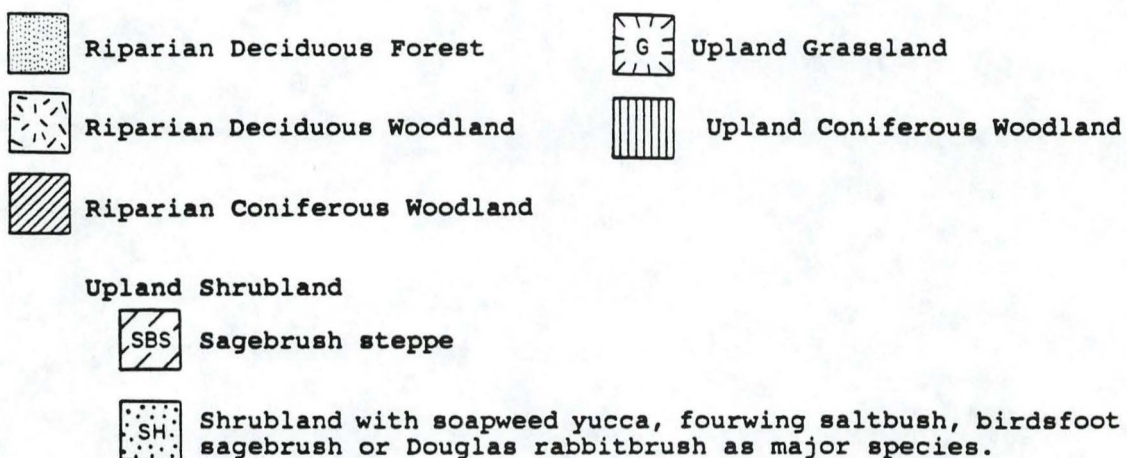
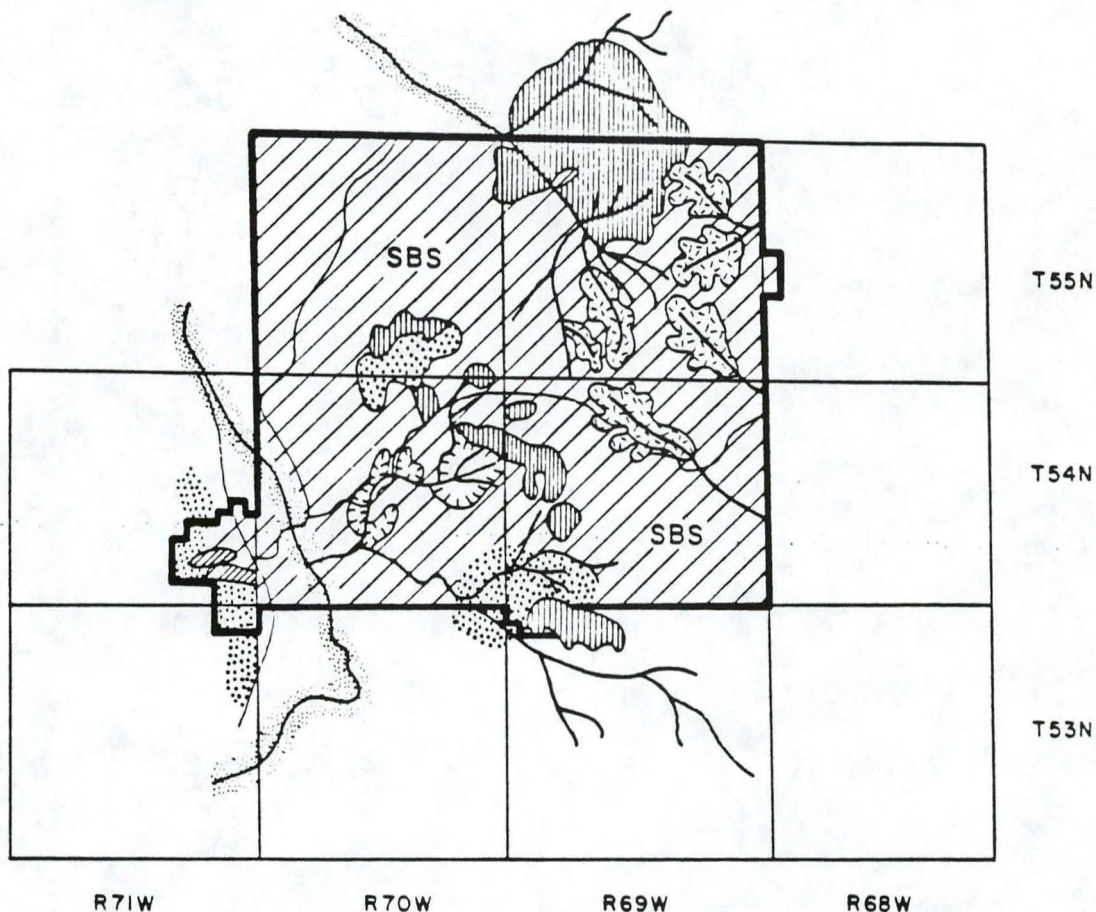
FIG. 3.31 The Cheyenne River Deciduous Riparian Forest Corridor. Cottonwood stands are patchy along the river, but increase in size and density downstream. Although cottonwoods are reproducing in areas along the Cheyenne River, most populations in tributaries are composed of old trees and this vegetation type is disappearing on the tributaries. 10/22/92 Lynch Road



FIG. 3.32 Aquatic and riparian habitat in the Little Powder River Reservoir wildlife enclosure. The majority of the wildlife enclosures are associated with man-made riparian areas. These are important patches for waterfowl. The native riparian area along the drainage is outside of the enclosure where the decadent cottonwood trees are beyond the dam in the background. 10/17/92 Spring Creek area.



FIG. 3.33 Gleason Reservoir (seasonally dry) in the Spring Creek area. Willows were planted along the perimeter. The flat bottom has developed because of sediment aggradation from the eroding badlands upstream. 10/17/92 Quintana oil field area, Spring Creek.



Source: Orthophotoquad aerial photointerpretation and field work, Douglas Ranger District and Medicine Bow National Forest Staff, 1992

**FIGURE 3.34 VEGETATION MODEL FOR THE SPRING CREEK UNIT**



FIG. 3.35 Old ponderosa pine trees, Spring Creek area. Populations of large, old ponderosa pines are found in the northern part of the Duck Creek Breaks. This site is adjacent to two remnant aspen stands. 10/17/92 Northern Spring Creek Unit.

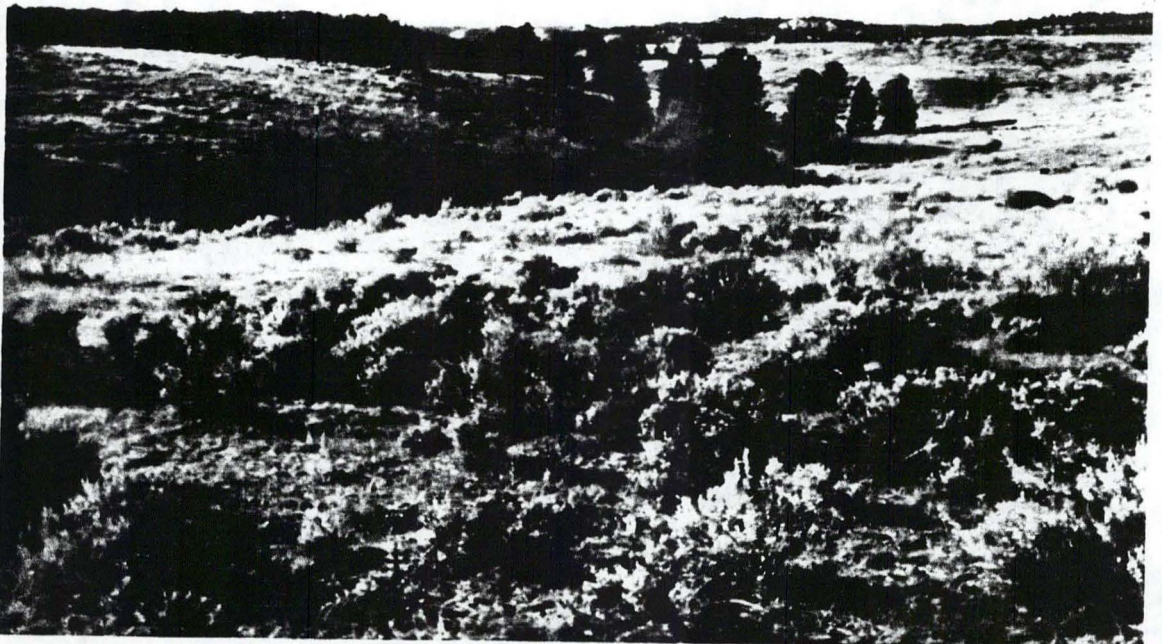


FIG. 3.36 Woody draws with hawthorne, chokecherry, snowberry, currant, whitestem goosberry and rose are found in the Spring Creek Unit. Deeper draws also support relict boxelder populations. Similar vegetation is characteristic of North and South Dakota and Nebraska. It is unusual for Wyoming. 10/17/92 Northern Spring Creek Unit.



FIG. 3.37 Woody draws create corridors with cover and food for wildlife in the sagebrush steppe matrix of the eastern part of the Spring Creek Unit. 10/17/92



FIG. 3.38 Corridors in badland areas are usually vegetated with grasses. Farther down the drainages cottonwood trees will grow in these riparian corridors in the sagebrush-grassland matrix. Where floodplain terraces occur, riparian shrubland will also develop. 10/10/92 Dugout area, Cheyenne River Basin.

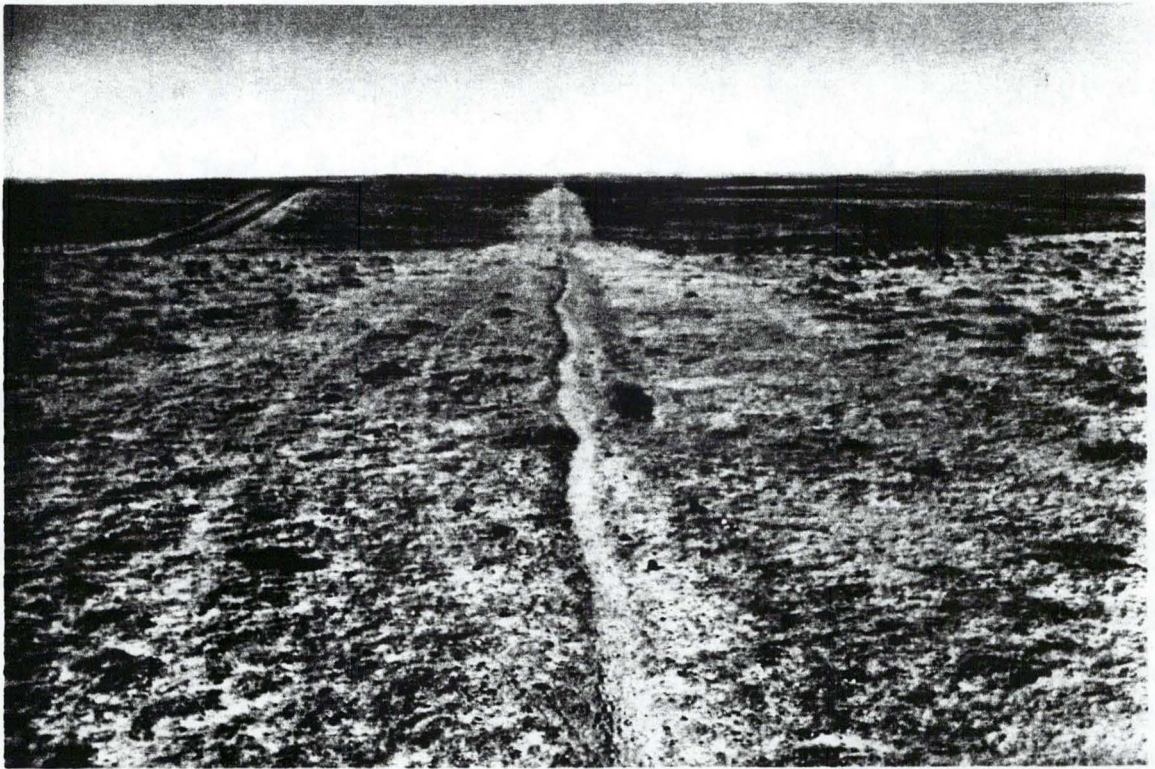


FIG. 3.39 Human-created corridors. Road and Panhandle Eastern Pipeline. The pipeline corridor forms a grassy lane in the sagebrush shrub-steppe. Cattle have worn a trail down the center and antelope use the cattle trail. Prairie dogs may also colonize these kinds of areas. 10/22/92 Cheyenne River Basin

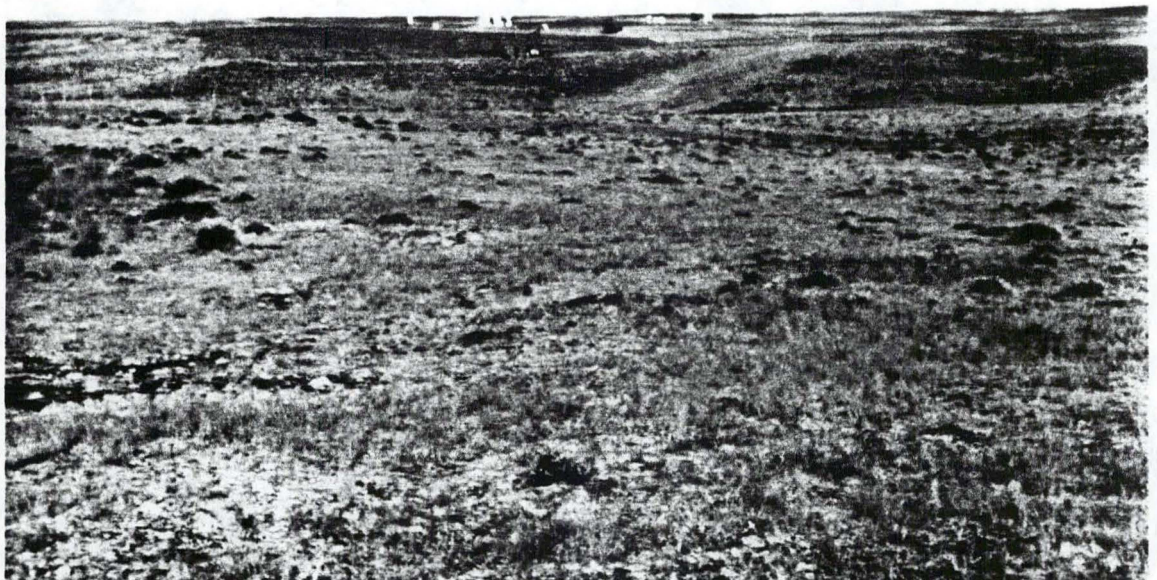


FIG. 3.40 Patches and corridors associated with oil fields in sagebrush shrubland. These change biological diversity on a small scale. 10/22/92 NE of Bill.

catalogue of plants for the entire Powder River Basin. Additional species from the Upton-Osage and Spring Creek areas would bring the total to an estimated 250 vascular plant species. Figures 3.41 and 3.42 show where collections have been made by the Rocky Mountain Herbarium staff (1978-79 and 1983-84) and the Thilenius (1992) study. More information on plant species is needed for the Cow Creek Buttes area, the Upton-Osage area and the Spring Creek area, especially for the woody draws and woodlands. Also the classification database needs to be extended to the areas not included in the Thilenius (1992) study.

#### **Threatened, Endangered, Candidate and Disjunct Plant Species**

There are no listed (C1) Threatened or Endangered plant species known from the Thunder Basin National Grassland. Two Candidate Threatened and Endangered plant species are found on or near the TBNG. Candidate species are classified as C2 or C3 depending on criteria listed in the Endangered Species Act. C2 species are eligible for further study; C3 species are likely to be removed from the list in the future because survey work indicates that they are not at critical population levels.

*Astragalus barrii* (Barr's milkvetch) is presently a C2 species but will be reclassified as C3 species in 1993, based on 1991 survey work by the Nature Conservancy. *Oryzopsis contracta* (contracted Indian-ricegrass) is known from scattered areas of the Powder River Basin and expected to occur on the Thunder Basin National Grassland. It is classified as a C2 species. Six other species currently being tracked by the Wyoming Natural Diversity Database are disjuncts which are more plentiful in other parts of the Great Plains (Table 3.7) (Fertig, 1992).

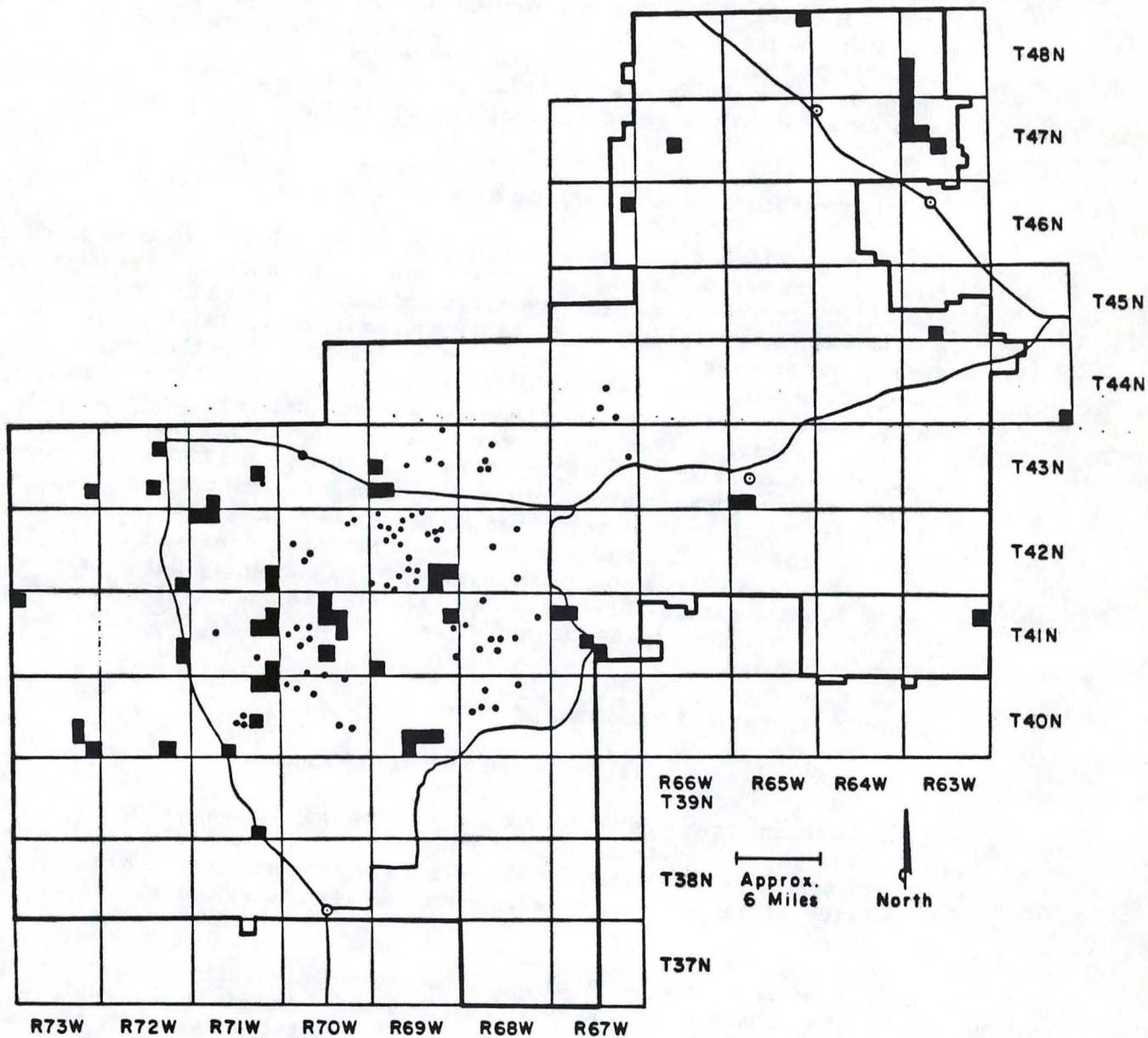
#### **TERRESTRIAL FAUNA BIOLOGICAL DIVERSITY**

##### **Life forms and indicator species**

This section contains information on the biological diversity of terrestrial vertebrate animals. There is no information available in Forest Service or Wyoming State Game and Fish records on the biological diversity of terrestrial invertebrates on the Thunder Basin National Grassland.

The preceeding description of plant biological diversity on the Thunder Basin National Grassland was based mostly on geology, landform, landscapes and plant communities. This exemplifies mainly a Coarse-Filter approach. The broad-scale descriptions are an appropriate framework for plant community and plant species biological diversity. Those descriptions also provide a useful framework in which to place animal community and animal species biological diversity.

Wildlife populations of birds, reptiles and mammals (terrestrial vertebrates) have many complex relationships to vegetation and landforms. Each wildlife species has particular preferences and/or requirements for species survival. Some requirements are very narrow and others can be met by a variety of vegetation types or landforms with associated habitat features. Wildlife biologists often use the

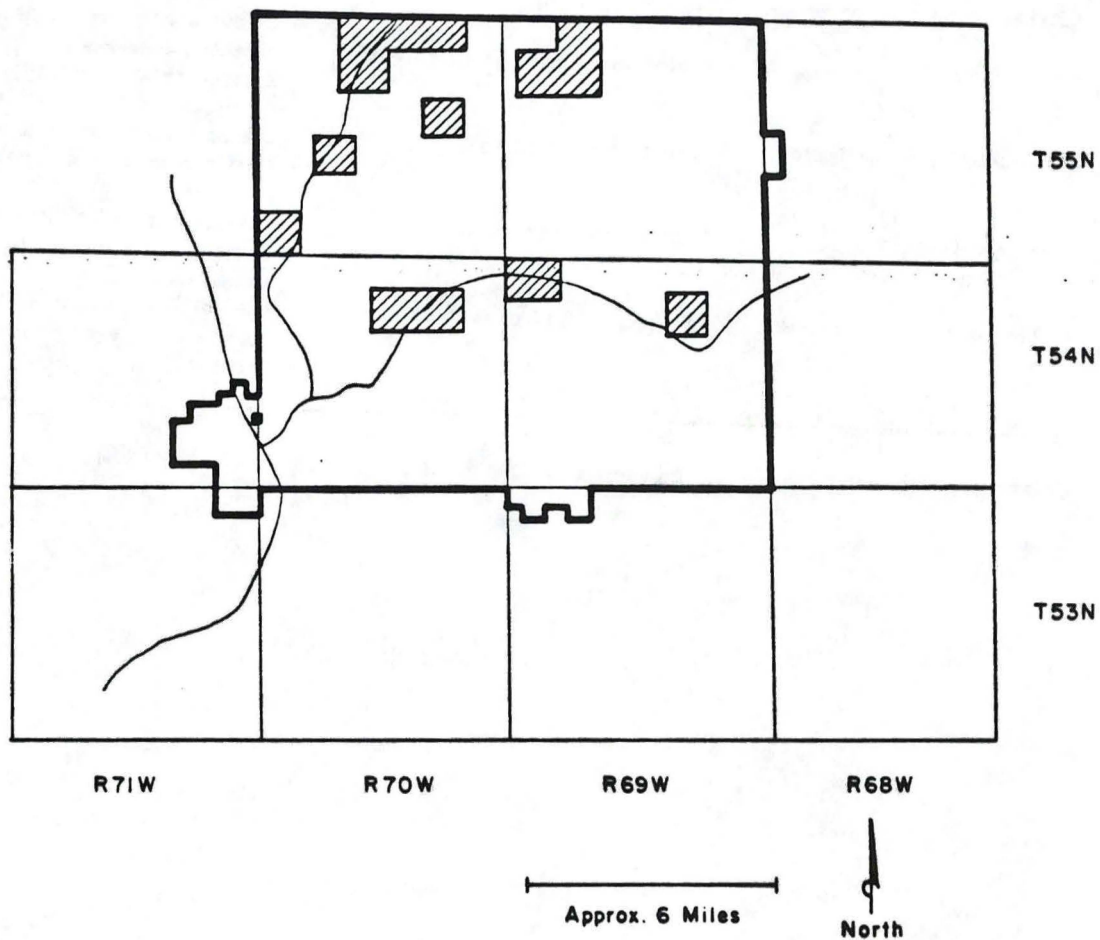



■ Solid polygons denote sections where floristic collections were made by the Rocky Mountain Herbarium staff in 1978-79 for the Powder River Basin Study, and 1983-84 for the Black Hills Study. Source: Rocky Mountain Herbarium, Laramie, WY

● Points denote approximate locations of sites where species composition and cover measurements were made by staff from the Rocky Mountain Forest and Range Experiment Station in Laramie, WY, for the purposes of a vegetation classification for the Cheyenne River Basin.

Source: Thilenius, J. and G. Brown. 1992. Vegetation on semi-arid rangelands, Cheyenne River Basin, Wyoming. RMFRES Fort Collins USDA Forest Service (in press)

**FIGURE 3.41 PLANT COLLECTION SITES**  
Cheyenne River Basin and Upton-Osage area



 Sections where floristic surveys were made by the Rocky Mountain Herbarium staff in 1978-79 for the Powder River Basin Study.  
 Source: Rocky Mountain Herbarium, Laramie, WY

**FIGURE 3.42 PLANT COLLECTION SITES Spring Creek Unit**

**TABLE 3.7      DISJUNCT PLANT SPECIES**

Common name	Scientific name	Range & Occurrence
old-field toad-flax	<i>Linaria canadensis</i> var <i>texana</i>	One population from Spring Creek area. Common in central & southern Great Plains
cut-leaved evening primrose	<i>Oenothera laciniata</i>	Northern Converse County. Rare in WY but common in the Great Plains
rosy palafoxia	<i>Palafoxia rosea</i> var <i>macrolepis</i>	Northern Converse County. Collected 5 times in WY. Mainly found in Oklahoma and the Texas Panhandle
crown-seed fetid marigold	<i>Pectis angustifolia</i>	One population on TBNG near the Jacobs land exchange site. Found in Kansas and Nebraska.
round woolly-heads	<i>Psilocarphus brevissimus</i>	One collection on TBNG in SE Campbell County. Rare composite on dry shores and ponds.
small-flowered fame flower	<i>Talinum parviflorum</i>	One collection near Bill. Mainly found in the eastern and central Great Plains

Source: Wyoming Natural Diversity Database, 1992

life form system developed by Jack Ward Thomas (Thomas, 1979) to group wildlife species with similar habitat requirements for feeding and reproduction into a level comparable to the concept represented by plant community types. This system does not differentiate plant community types as descriptors, but rather depends on habitat structure which is partly a function of the physiognomic characteristics of the vegetation (tree, shrub, grass).

There are sixteen life form categories. Table 3.8 provides a life form list with examples of species from the Thunder Basin National Grassland. A list for all species in the TBNG, assigned to life form categories, can be found in Blunt (1980).

The life form concept is a very useful management tool and is one of the foundations for the concept of using Indicator Species in Forest Plans. Indicator species in the Medicine Bow National Forest Plan (1985) are of three types: 1. featured species 2. ecological indicator species 3. threatened and endangered species. This exemplifies the fine-filter strategy. Management efforts have historically been directed toward indicator species on the premise that management for these would insure habitat management for the other wildlife represented by that species.

Ecological Indicator species recognized in the 1985 Medicine Bow National Forest and Thunder Basin National Grassland Land and Resource Management Plan are listed in Table 3.9.

A biological diversity assessment should properly include all species. At present, the information on many species, including some of the indicator species is nonexistent or very sparse both spatially and temporally. Much of the population data needed to evaluate wildlife biological diversity is obtained through Wyoming State Game and Fish Department Surveys. The kinds of wildlife evaluated and the kinds of information they collect fills only part of the needs of the Forest Service for information on wildlife biological diversity. Censusing of populations by Forest Service biologists has been limited by funding.

A prairie dog management plan was developed in 1981 for the TBNG. In that plan, guidelines were established for the management of prairie dogs in two separate areas. These areas are: 1. the Rosecrans Black-footed Ferret Potential Habitat Area, and: 2. the rest of the Thunder Basin National Grassland. The management plan designates criteria for the control or reduction of prairie dog town size through U.S. Fish and Wildlife Service approved techniques using zinc phosphide poison approved by the U.S. Fish and Wildlife Service and the EPA (see Prairie Dog Management Plan for the Thunder Basin National Grassland, Appendix G pages 107-110).

This plan also calls for the establishment of retention areas "for threatened or endangered species habitat and for general wildlife habitat" (Revised Prairie Dog Management Plan for Thunder Basin National Grassland, 1991) The Plan states that within the Rosecrans Black-Footed Ferret Potential Habitat Area " a maximum of 2240 acres"

**TABLE 3.9 LIFE FORM DESCRIPTIONS AND REPRESENTATIVE SPECIES OF THUNDER BASIN NATIONAL GRASSLAND**

<sup>1</sup> = MBNF featured species, <sup>2</sup> = ecological indicator species  
<sup>3</sup> = Threatened or endangered species <sup>4</sup> = candidate T&E species

Form	Reproduces	Feeds	Examples
1	in water	in water	all fish
2	in water	on ground, in shrubs and/or trees	tiger salamander Woodhouse's toad <sup>2</sup>
3	on ground around water or on floating or emergent vegetation	in water, on ground in shrubs and trees	snapping turtle, western garter snake, mtn. plover <sup>2,4</sup> , long-billed curlew <sup>2,4</sup> , black tern <sup>4</sup> , Preble's jumping mouse <sup>4</sup>
4	in cliffs, caves, rims or talus	on ground or in air	ferruginous hawk <sup>2,4</sup> peregrine falcon <sup>3</sup>
5	on ground without specific water, cliff rim or talus association	on ground	western rattlesnake, bull snake sage grouse <sup>2</sup> , upland sandpiper <sup>2</sup> , Black Hills redbelly snake <sup>4</sup> , elk <sup>1</sup> , mule deer <sup>1</sup> , antelope <sup>1</sup>
6	on ground	in shrubs, trees, or air	common nighthawk
7	in shrubs	on ground, in water or air	Brewer's sparrow <sup>2</sup> loggerhead shrike <sup>4</sup>
8	in shrubs	in shrubs, trees or air	yellow-breasted chat <sup>2</sup> willow flycatcher <sup>2</sup>
9	primarily in deciduous trees	in shrubs, trees or air	cedar waxwing
10	primarily in conifers	in shrubs, trees or air	red crossbill <sup>2</sup>
11	in trees	on ground, in shrubs, trees or air	merlin
12	on very thick branches	on ground or on water	golden eagle <sup>2</sup> , bald eagle <sup>3</sup> white-faced ibis <sup>4</sup>
13	makes own hole in tree	on ground, in shrubs, trees or air	red-headed woodpecker <sup>2</sup>
14	in a hole made by another species or naturally occurring	on ground, in water or air	house wren <sup>2</sup> , fringed myotis <sup>4</sup>
15	underground burrow	on or underground	black-tailed prairie dog <sup>2</sup> black-footed ferret <sup>3</sup> , swift swift fox <sup>4</sup>
16	underground burrow	in water, on ground or in air	beaver

from: Life form categories from Maser, Thomas and Anderson (1984) Wildlife species examples from Medicine Bow National Forest Plan (1985); Douglas District records and Blunt (1980).

**TABLE 3.9      ECOLOGICAL INDICATOR SPECIES AND REPRESENTATIVE HABITAT OR ECOLOGICAL CONDITION**

<b>Species</b>	<b>Representative Habitat or Ecological Condition</b>
prairie vole	dense grass cover.
black-tailed prairie dog	short grass prairie and specific ecological range conditions.
sage grouse	sagebrush community.
yellow-breasted chat	only species in its life form (*) riparian thickets with surrounding grassland in satisfactory condition.
golden eagle	sensitive to disturbance in nesting and roosting areas.
Brewers sparrow	representative of large shrub communities.
willow flycatcher	representative of brush thickets near water and at least moderate riparian ecological condition.
mountain plover	listed as a sensitive species by the State of Wyoming short-midgrassland in satisfactory condition.
upland sandpiper	listed as a sensitive species by the State of Wyoming mid-tall moist grasslands in satisfactory condition.
ferruginous hawk	only species representative of its life form.*
red crossbill	only species representative of its life form.*
house wren	only species representative of its life form.*
long-billed curlew	listed as a sensitive species by the State of Wyoming.
red-headed woodpecker	representative of late successional cottonwood and ponderosa pine stages. optimum habitat capability in riparian and snags.
woodhouse toad	representative of permanent water and associated herbaceous cover.

**Source: Medicine Bow National Forest Land and Resource Management Plan, FEIS 1985 page III-41**

**\* Life form is defined by Thomas, 1979 as "a group of wildlife species whose requirements for habitat are satisfied by similar successional stages within given plant communities."**

of prairie dog towns will be maintained. 3160 acres are to be maintained outside of the Rosecrans on the rest of the TBNG to give a total of 5400 acres of retained prairie dog towns. Towns not meeting specific retention criteria are available for control. As of 1990, 14,374 acres prairie dog towns existed on TBNG. In 1991 and 1992 prairie dog towns generally experienced significant growth and subsequent control. In 1991 approximately 7200 acres were treated with zinc phosphide and about 4300 acres were treated 1992. Prairie dog populations are routinely treated on intermingled private lands. In the past, poisons such as strychnine, not currently licensed by EPA, were used to control prairie dogs.

The USDA Animal and Plant Health Inspection Service, Animal Damage Control Division (APHIS-ADC) conducts other animal damage control activities on Federal, State and private lands which affect populations of specific predatory species. APHIS-ADC has the primary responsibility for animal damage control on National Forest System Lands but the methods must comply with the Medicine Bow National Forest Plan. Coyotes are the only predatory animals currently controlled under this program. Aerial gunning is the primary means of control. In the past, poison baits and traps were also used. County Boards of Predator Control, which operate both separately and in cooperation with APHIS-ADC also carry out animal damage control. Any carnivorous animal deemed to cause damage can be targeted for control by these programs.

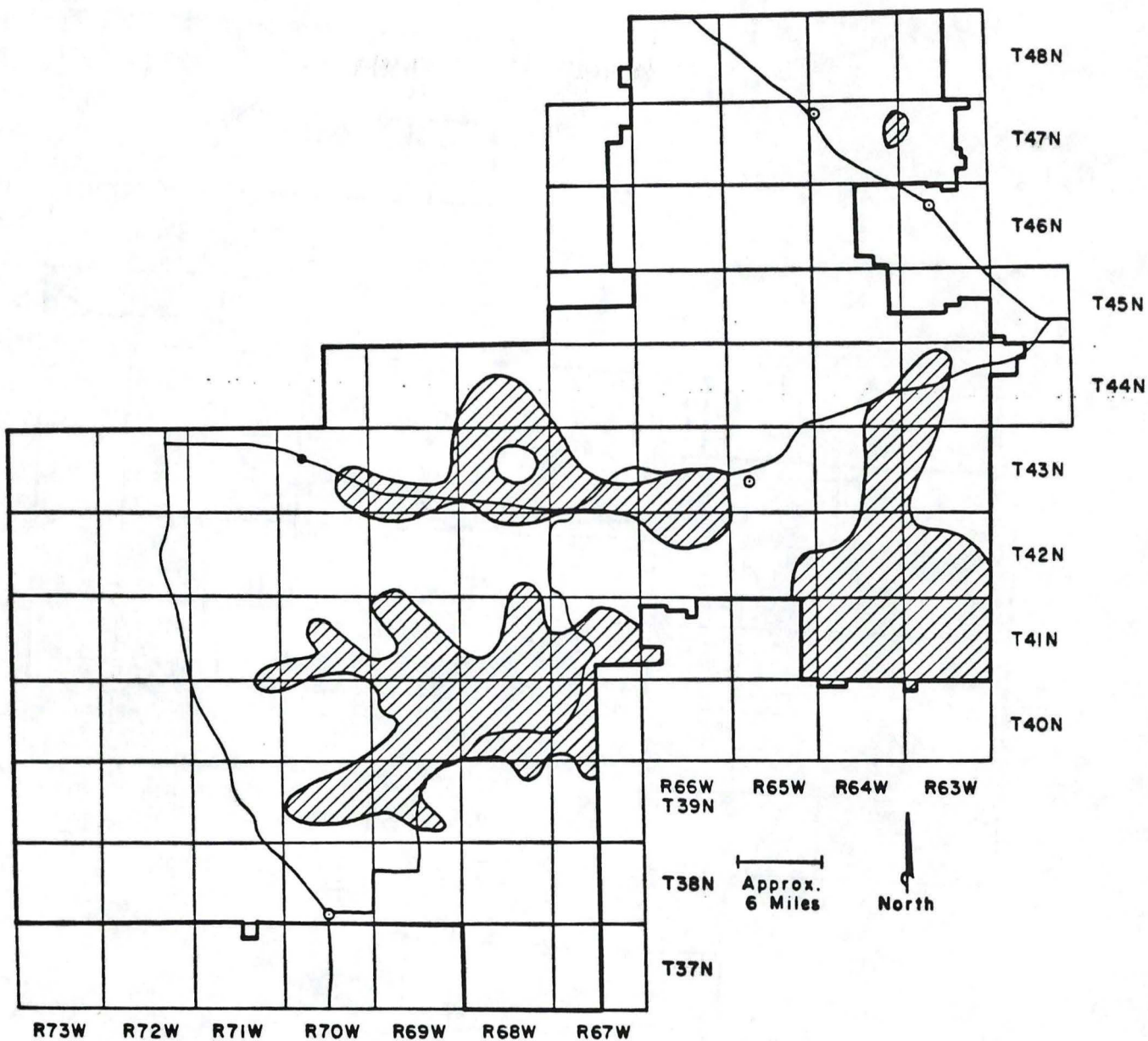
Population information on raptors and mountain plovers and location and population information on sage grouse leks has been assembled by the coal mines and the Douglas Ranger District since 1981. This information was combined with Wyoming Game and Fish data to produce the wildlife distribution maps. Information on population distribution for bald eagles, mountain plovers, sage grouse leks, golden eagles, ferruginous hawks and prairie dogs was used to create the distribution maps shown in Figures 3.43 - 3.46.

Information on Threatened and Endangered Species (both listed species and candidate species), is presented in detail in two specialist reports prepared in 1992 for the Gas and Oil EIS (Byer and Cartwright, 1992; Cartwright, 1992). A summary of wildlife biological diversity and a summary of the information on Threatened and Endangered Species is presented below.

#### **Species-vegetation relationships**

There are approximately 311 vertebrate wildlife species (birds, mammals, reptiles, and amphibians ) which occur on TBNG. There are 220 birds, 62 mammals, 15 reptiles, and 6 amphibians. There are 29 species of fishes. These numbers represent approximate species numbers based on known or potential species occurrences. Amphibians and fish will be discussed further in the aquatic vertebrate and invertebrate section. A terrestrial fauna list is in Table 3.10.

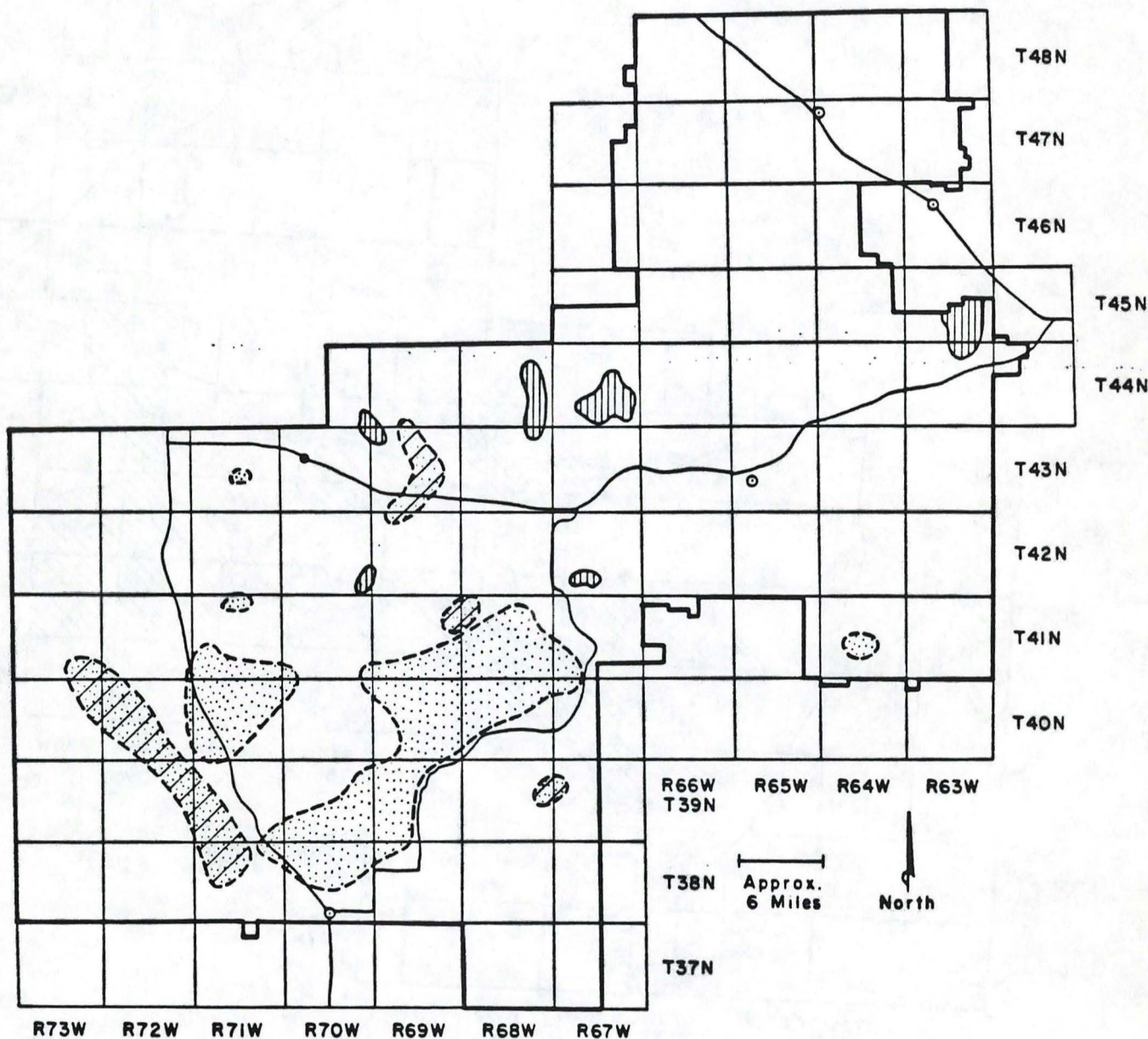
Blunt (1980) listed species by life form stratified by general vegetation categories. These categories were adapted to nest into the large scale vegetation classification concept used earlier in this






 **Prairie Dog Colony Areas (1976-1992)**

**Sources:** Douglas Ranger District Records, Coal Mine Records,  
Wyoming Game and Fish Department

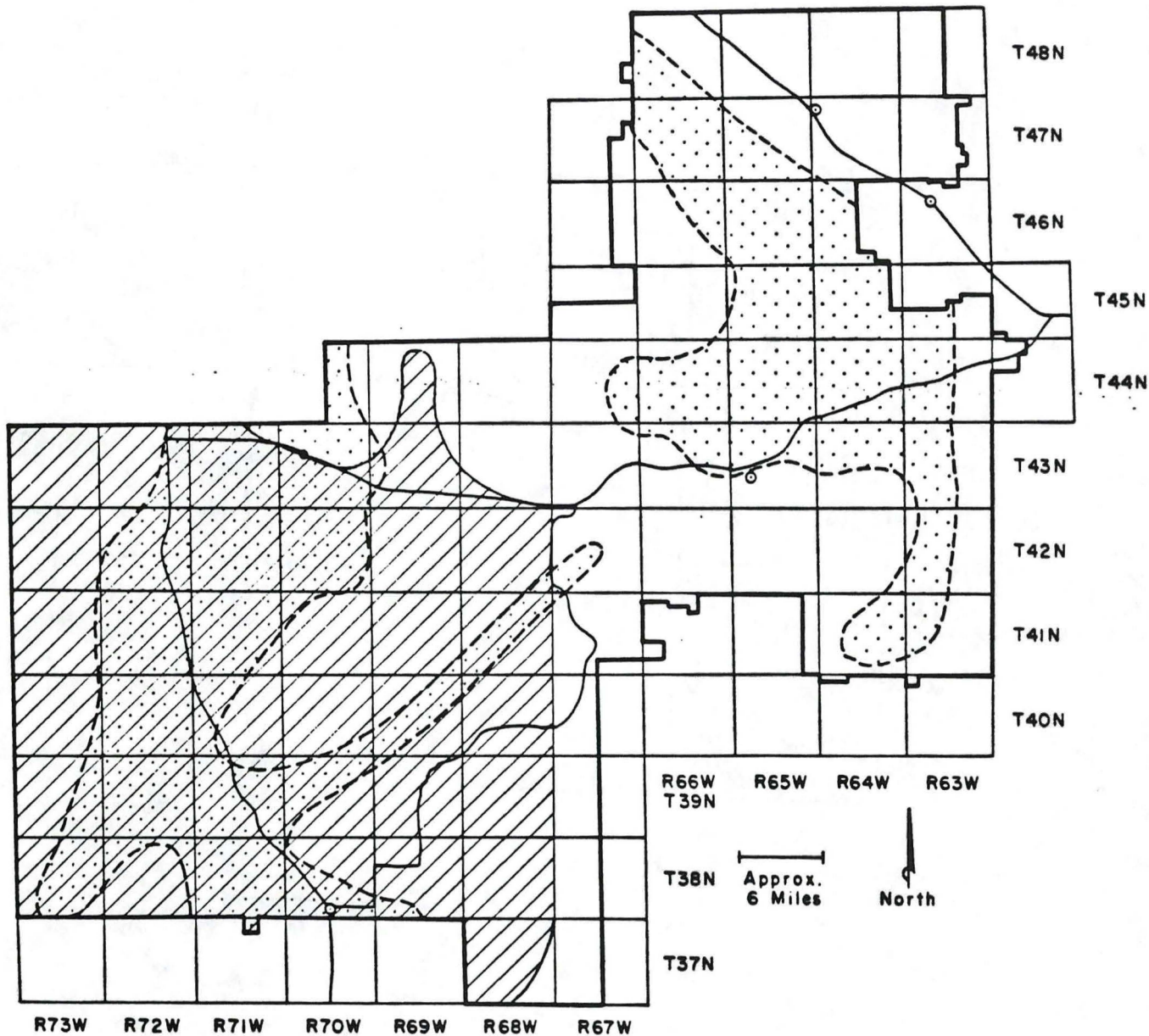
**FIGURE 3.43 MODEL OF DISTRIBUTION OF PRAIRIE DOG COLONIES**  
Cheyenne River Basin and Upton-Osage area





-  Bald Eagles (1981-1992)
-  Mountain Plovers (1981-1992)
-  Sage Grouse Leks (1981-1992)

Sources: Douglas Ranger District Records, Coal Mine Records,  
Wyoming Game and Fish Department Record

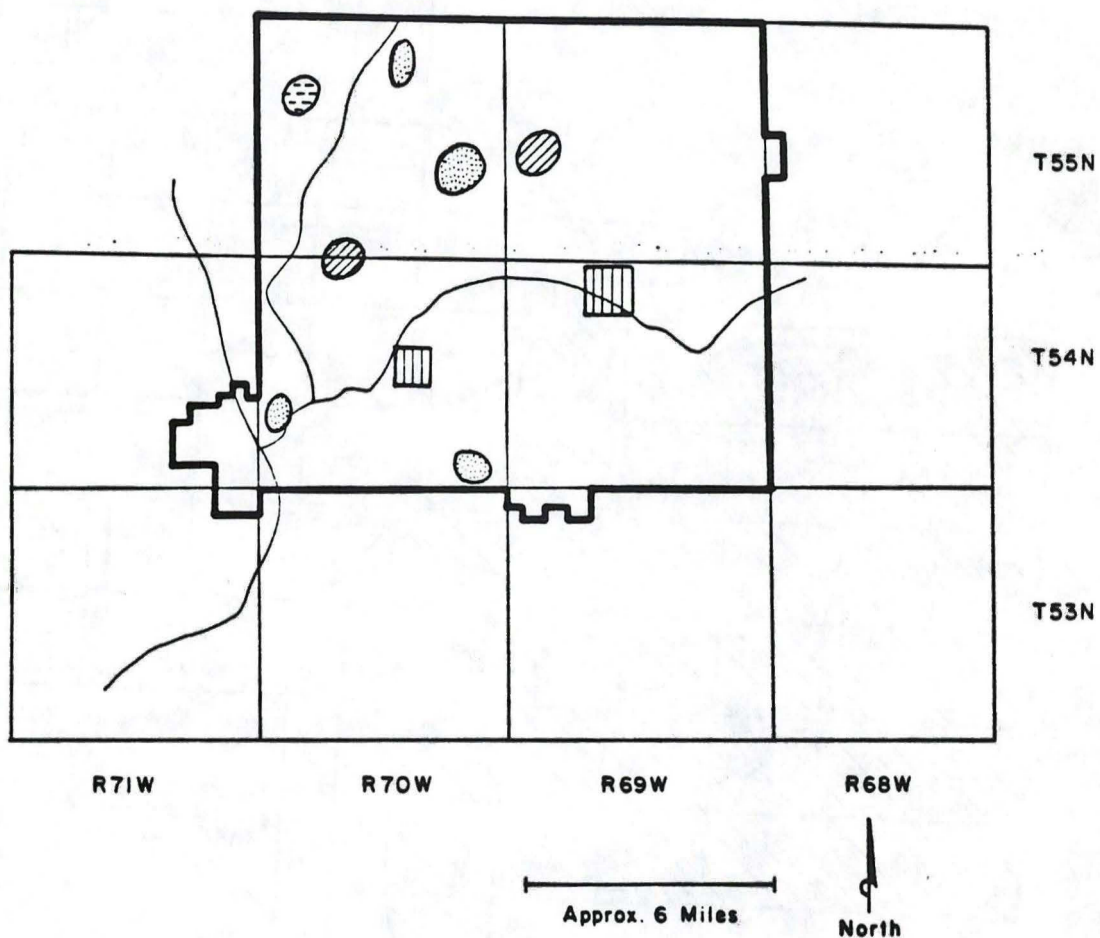
**FIGURE 3.44 MODEL OF DISTRIBUTION OF BALD EAGLES, MOUNTAIN PLOVERS  
AND SAGE GROUSE LEKS  
Cheyenne River Basin and Upton-Osage area**







-  Golden Eagles (1981-1992)
-  Ferruginous Hawks (1981-1992)

Sources: Douglas Ranger District Records, Coal Mine Records,  
Wyoming Game and Fish Department

**FIGURE 3.45 MODEL OF DISTRIBUTION OF GOLDEN EAGLES and FERRUGINOUS HAWKS**  
- Cheyenne River Basin and Upton-Osage areas



-  Prairie Dogs (1976-1992)
-  Sage Grouse (1992)
-  Golden Eagle (1982-1991) (to be inspected in 1993)
-  Ferruginous Hawk (verified in 1992 - length of record unknown)

Sources: Douglas Ranger District Records, Wyoming State Game and Fish Dept.

**FIGURE 3.46 DISTRIBUTION OF GOLDEN EAGLES AND FERRUGINOUS HAWKS  
Spring Creek Unit**

TABLE 3.10

## VERTEBRATE FAUNA SPECIES LIST

\* denotes management indicator species for TBNG

<b>FISH</b>	29 species	
	goldeye	mountain sucker
	brown trout	northern redhorse
	rainbow trout	channel catfish
	brook trout	black bullhead
	carp	stonecat
	flathead chub	plains killfish
	plains minnow	plains topminnow
	brassy minnow	largemouth bass
	sand shiner	smallmouth bass
	golden shiner	green sunfish
	fathead minnow	bluegill
	longnose dace	rock bass
	horneyhead chub	crappie
	river carpsucker	yellow perch
	white sucker	
<b>AMPHIBIANS</b>	6 species	
	tiger salamander	Woodhouse's toad*
	plains spadefoot toad	chorus frog
	Great Plains toad	leopard frog
<b>REPTILES</b>	15 species	
	painted turtle	eastern yellow-bellied racer
	snapping turtle	red-bellied snake
	spiny soft-shell turtle	bullsnake
	sagebrush lizard	red-sided garter snake
	eastern short-horned lizard	wandering garter snake
	plains hog-nose snake	western plains garter snake
	western smooth green snake*	prairie rattlesnake
	pale milk snake	
<b>BIRDS</b>	228 species, 60 neotropical migrants	
	<u>See Thunder Basin National Grassland Checklist of Birds, 1992</u>	
	common loon	white-throated swift
	Pacific loon	broad-tailed hummingbird
	pied-billed grebe	belted kingfisher
	horned grebe	red-headed woodpecker*
	eared grebe	downy woodpecker
	western grebe	hairy woodpecker*
	American white pelican	Lewis' woodpecker
	double-crested cormorant	yellow-bellied sapsucker*
	great blue heron	northern flicker
	green-backed heron	olive-sided flycatcher
	black-crowned night heron	willow flycatcher*
	American bittern	least flycatcher
	white-faced ibis	Hammond's flycatcher
	Canada goose	dusky flycatcher
	snow goose	cordillerian flycatcher
	greater white-fronted goose	ash-throated flycatcher
	green-winged teal	western wood-pewee
	blue-winged teal	Say's phoebe
	cinnamon teal	Cassin's kingbird
	hooded merganser	western kingbird
	common merganser	eastern kingbird
	red-breasted merganser	horned lark

**TABLE 3.10 contd. Vertebrate Fauna Species List**

\* denotes management indicator species for TBNG

**BIRDS (contd)**

northern shoveler	tree swallow
gadwall	violet-green swallow
canvasback	northern rough-winged swallow
ring-necked duck	bank swallow
ruddy duck	cliff swallow
lesser scaup	barn swallow
common goldeneye	Steller's jay
mallard	blue jay
northern pintail	pinyon jay
bufflehead	Clark's nutcracker
turkey vulture	black-billed magpie
osprey	American crow
bald eagle*	common raven
golden eagle*	Black-capped chickadee
northern harrier	red-breasted nuthatch
sharp-shinned hawk	white-breasted nuthatch
Cooper's Hawk	pygmy nuthatch
Swainson's hawk	rock wren
red-tailed hawk	Bewick's wren
ferruginous hawk*	house wren*
northern goshawk*	Ruby-crowned kinglet
American kestrel	eastern bluebird
merlin	western bluebird
peregrine falcon*	mountain bluebird
gyrfalcon	Townsend's solitaire
prairie falcon	veery
gray partridge	Swainson's thrush
chukar	hermit thrush
sage grouse*	gray-cheeked thrush
wild turkey*	American robin
Virginia rail	gray catbird
sora	northern mockingbird
American coot	sage thrasher
Sandhill crane*	brown thrasher
black-bellied plover	American pipit
semi-palmated plover	Sprague's pipit
mountain plover*	Bohemian waxwing
killdeer	cedar waxwing
American avocet	northern shrike
greater yellowlegs	loggerhead shrike
lesser yellowlegs	European starling
solitary sandpiper	solitary vireo
spotted sandpiper	warbling vireo
upland sandpiper*	red-eyed vireo
western sandpiper	orange-crowned warbler
least sandpiper	yellow warbler
Baird's sandpiper	yellow-rumped warbler
pectoral sandpiper	Townsend's warbler
stilt sandpiper	Blackpoll warbler
willet	black and white warbler
long-billed curlew*	MacGillivray's warbler
Hudsonian godwit	American redstart
marbled godwit	ovenbird
short-billed dowitcher	northern waterthrush
common snipe	common yellowthroat
Wilson's phalarope	yellow breasted chat*

TABLE 3.10 contd.

## Vertebrate Fauna Species List

\* denotes management indicator species for TBNG

## BIRDS (contd)

red-necked phalarope	western tanager
Franklin's gull	house sparrow
Bonaparte's gull	snow bunting
California gull	bobolink
herring gull	red-winged blackbird
ring-billed gull	western meadowlark
Forster's tern	yellow-headed blackbird
black tern	Brewer's blackbird
common tern	common grackle
yellow-billed cuckoo	brown-headed cowbird
rock dove	Orchard oriole
mourning dove	northern oriole
barn owl	rosy finch
western screech owl	purple finch
great-horned owl	house finch
snowy owl	red crossbill*
burrowing owl	common redpoll
long-eared owl	pine siskin
short-eared owl	lesser goldfinch
northern saw-whet owl	American goldfinch
common nighthawk	evening grosbeak
common porwill	black-headed grosbeak
	rose-breasted grosbeak
	Lazuli bunting
	rufous-sided towhee
	American tree sparrow
	chipping sparrow
	clay-colored sparrow
	Brewer's sparrow*
	vesper sparrow
	lark sparrow
	sage sparrow
	savanna sparrow
	Baird's sparrow
	grasshopper sparrow
	song sparrow
	Lincoln's sparrow
	white-throated sparrow
	white-crowned sparrow
	Harris's sparrow
	lark bunting
	dark-eyed junco
	McCown's longspur
	lapland longspur
	chestnut-collared longspur

**TABLE 3.10 concl.****Terrestrial vertebrate fauna species list**

\* denotes management indicator species for TBNG

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**MAMMALS 62 species****Small mammals (57 species)**

vagrant shrew	Plains harvest mouse
masked shrew	deer mouse
Merriam shrew	white-footed mouse
little brown myotis	northern grasshopper mouse
Keen's myotis	bushy-tailed woodrat
long-eared myotis	
long-legged myotis	meadow vole
small-footed myotis	long-tailed vole*
big-brown bat	silky pocket mouse
hoary bat	hispid pocket mouse
red bat	prairie vole*
spotted bat	sagebrush vole
fringed myotis	muskrat
desert cottontail	sagebrush vole
Nuttall's cottontail	house mouse
white-tailed jackrabbit	Preble's meadow jumping mouse
black-tailed jackrabbit	porcupine
least chipmunk	coyote
thirteen-lined ground squirrel	red fox
fox squirrel	swift fox
black-tailed prairie dog*	raccoon
red squirrel	ermine
Northern flying squirrel	long-tailed weasel
Plains pocket gopher	mink
northern pocket gopher	black-footed ferret (extirpated)*
Olive-backed mouse	badger
Ord's Kangaroo rat	spotted skunk
beaver*	striped skunk
western harvest mouse	bobcat

**Large mammals (5 species)**

elk*	white-tailed deer
mule deer*	pronghorn antelope*
mountain lion	

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Sources: Blunt, 1980; Thunder Basin National Grassland Checklist of Birds, 1992;  
Land and Resource Management Plan, Medicine Bow National Forest, 1985;  
1992 List of Migrants, Partners in Flight Newsletter Vol 2 No. 1 and  
Byer and Cartwright, 1992.

report. One difficulty with this is that while the uplands are differentiated according to physiognomic type (shrubland, woodland and grassland); the riparian areas could not be categorized by physiognomic type because the life-form -vegetation classification in Blunt (1980) did not permit that. Analysis to evaluate the relationship of community types to wildlife habitat as expressed through life form has not been done but would be very useful for relating plant and animal biological diversity. This has been done in Region 6 for Rangelands in southeastern Oregon (Thomas et al, 1984; Maser et al, 1984).

Table 3.11 is a model of wildlife diversity and vegetation type developed by aggregating species from the life form categories /vegetation type relationships in Blunt (1980). In the TBNG ecosystems, upland vegetation has less vertical and horizontal structure than riparian vegetation which can include tree, shrub and grass categories. The riparian category has the greatest wildlife species richness, when compared by this method, to the upland categories, which are divided by physiognomic type. It has the highest species richness for birds and nearly the highest other species groups. The grasslands have the next highest species diversity. It was difficult to evaluate sagebrush steppe in this system since it has characteristics of both shrubland and grassland, depending on the scale and patch structure. Shrublands and woodlands have less wildlife species richness, but contain species with special ecological requirements or adaptations, such as salt tolerance, requirements for vertical structure or specialized food sources.

#### **Threatened, Endangered and Candidate Vertebrate Species**

There are three Threatened or Endangered (T&E) species which may occur on TBNG according to the U.S. Fish and Wildlife Service. They are the bald eagle, the peregrine falcon, and the black-footed ferret. At this time the bald eagle is the only T&E species to spend significant time on the TBNG. It is a winter resident of the TBNG. There are 14 known bald eagle winter roost areas and 4 known nest sites where bald eagles have attempted to nest. As of the summer of 1992, no bald eagles have successfully fledged young on the TBNG, however bald eagle activity has been increasing. Based on wintering censusing done by the Douglas Ranger District, a definite upward trend has been discernible over the past several years (Medicine Bow NF annual monitoring report, 1991). Reported sightings of bald eagles remaining on TBNG through all or part of the summers have also increased. Peregrine falcons are considered to be migratory transients.

Based on ten years of extensive summer searches on the TBNG, the Forest Service has concluded that the black-footed ferret is not known to exist presently on the TBNG. The Wyoming Game and Fish Department concurred with the Forest Service findings (memo to the U.S. Fish and Wildlife Service, 3/5/91) stating "Based upon survey information presented at our January 15, 1991 meeting, it is obvious that black-footed ferrets no longer occur in the area."

There are also 10 Threatened or Endangered Candidate species which the U.S. Fish and Wildlife Service believes may exist on the TBNG. These

**TABLE 3.11****WILDLIFE SPECIES DIVERSITY IN VEGETATION TYPES**

Species Group (Number)		Upland Shrubland (%)		Upland Woodland		Upland Grassland		Riparian (Deciduous Forest, Forest, Shrubland and Grassland)	
Large mammals	(4)	4	(100%)	2	(50%)	4	(100%)	3	(75%)
Small mammals	(56)	23	(41%)	30	(54%)	37	(66%)	35	(63%)
Birds	(220)	75	(34%)	84	(35%)	111	(50%)	136	(62%)
Reptiles	(15)	7	(47%)	12	(80%)	10	(67%)	10	(67%)
Amphibians	(6)	0	(0%)	4	(67%)	6	(100%)	6	(100%)
TOTAL		109		132		168		190	

8

Adapted from Blunt(1980) using Douglas Ranger District 1992 data. This chart is an general model of species richness in vegetation types based on the relationship of the life form classification and vegetation categories which are based on physiognomic type and landscape position. Species may be counted for more than one vegetation type since requirements for feeding and/or reproduction (life form) are used as criteria and species a species may use more than one kind of area for feeding and reproduction.

are species classified as Category 1 or 2 by the U.S. Fish and Wildlife Service. Further information is contained in Specialist's Report and Biological Evaluation (Byer and Cartwright, 1992). These species include the mountain plover, swift fox, ferruginous hawk, black tern, loggerhead shrike, long-billed curlew, white-faced ibis, Black Hills redbelly snake, fringed myotis, and Preble's meadow jumping mouse.

The use of different vegetation types within Region 2, by threatened, endangered, and vulnerable species, was evaluated by Finch (1992). Finch (1992) determined the per cent of T&E or vulnerable species that occur in five broad vegetation categories; wetland and riparian - 55%, plains and upland grassland - 49%, mountain coniferous and deciduous forest - 42%, foothills shrublands and woodlands - 39%, specialized habitats like talus slopes, caves, and alpine - 20%. Table 3.12 models the general vegetation types Candidate species would use on the Thunder Basin National Grassland.

Information on these species indicates that listing these species may be appropriate but in most cases more information is still needed on populations and distribution. Further analysis is also needed to evaluate which community types provide important habitat.

#### **Wildlife exclosures and biological diversity**

Thirty small areas, totaling about 570 acres, have been fenced to exclude domestic livestock. These exclosures range in size from 2 to 100 acres. About half are less than 10 acres. Most are associated with ponds or seep areas. The majority are associated with man-made ponds or reservoirs. The names and locations of these exclosures is shown in Figure 3.47. These small patches make a small but valuable contribution to biological diversity, especially for wetland plant and animal species.

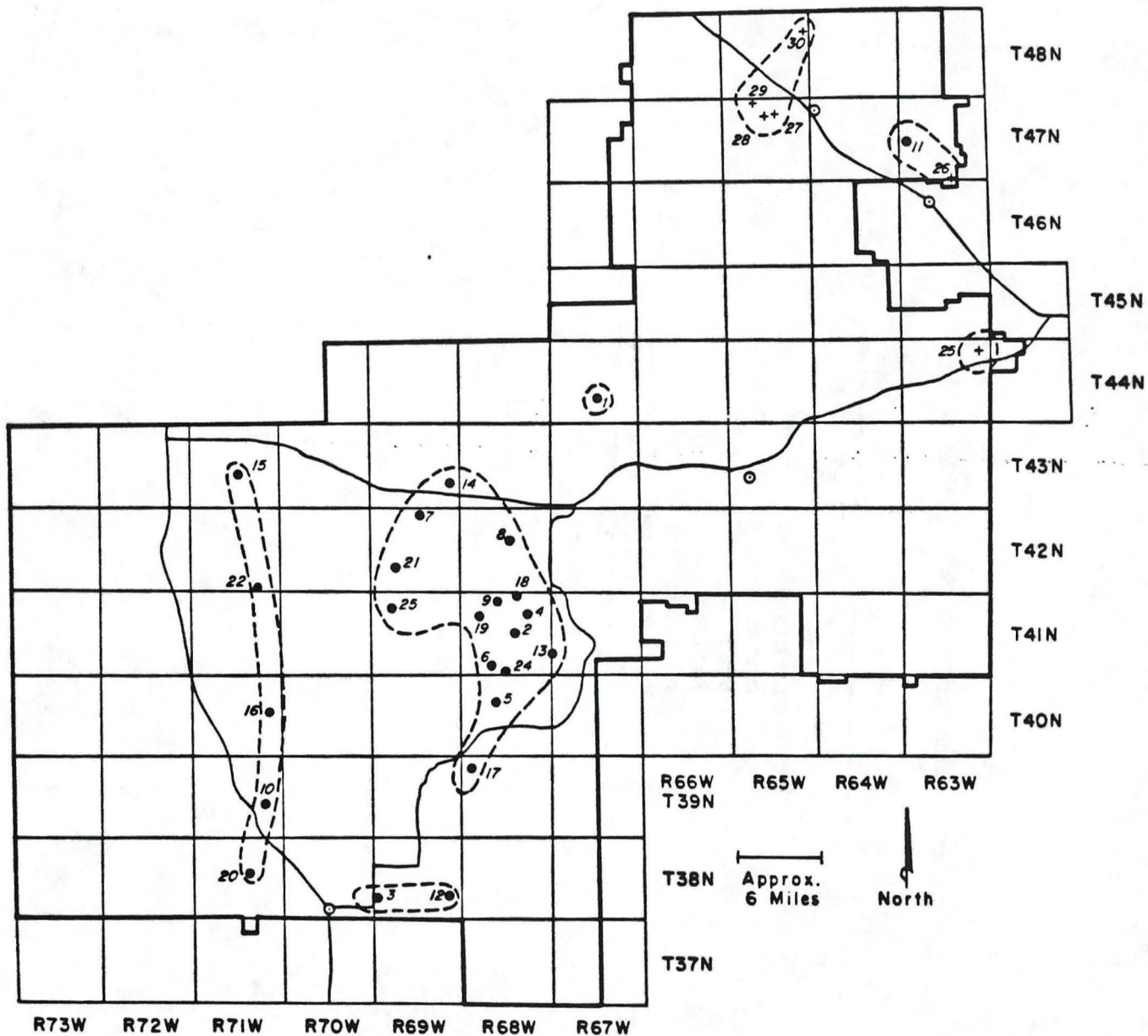
Other habitat improvement projects have been done in addition to the construction of wildlife exclosures. These projects include the construction of raptor perches in various habitats, the installation of man-made wildlife watering stations (guzzlers and water tanks from pipelines), and controlled burning for sage grouse habitat improvement. A series of waterfowl nesting structures and brushpiles for small mammals have also been established. Vegetation plantings have been done for bald eagle winter roost replacements (ponderosa pine); small mammal and bird habitat (willows, cottonwoods, chokecherry, rose and juniper), and riparian improvement (willow, cottonwood and cattails).

On TBNG there are several man-made reservoirs which support fisheries. Many of these are inside wildlife exclosures (Table 3.13).

**TABLE 3.12 EXPECTED OCCURRENCE OF CANDIDATE SPECIES IN MAJOR VEGETATION TYPES**

Species	Upland Shrubland	Upland Woodland	Upland Grassland	Riparian Deciduous Forest
Mountain plover*	X		X	
swift fox			X	
ferruginous hawk*			X	
black tern*				X
loggerhead shrike*	X	X	X	X
long-billed curlew*	X		X	
white-faced ibis*				X
Black Hills red-bellied snake		X	X	X
fringed myotis	X	X	X	
Preble's meadow jumping mouse				X

Adapted from Finch (1992) using Blunt (1980) and Douglas District information.  
\* = known occurrence. Others are within ranges but have no known populations  
on Thunder Basin National Grassland.



- |                               |                         |                      |
|-------------------------------|-------------------------|----------------------|
| 1. Cellars Pipeline           | 11. Kellogg Dam         | 21. School Creek     |
| 2. Clements Draw              | 12. Ketelson Reservoir  | 22. Teckla Windbreak |
| 3. Dry Climate Draw           | 13. Keyton Reservoir    | 23. West Beckwith    |
| 4. Dry Lake (a,b,c)           | 14. Krause              | 24. Wyatt Draw       |
| 5. Dull Draw                  | 15. Little Thunder Dam  | 25. Sixmile Dam      |
| 6. Evan's Draw                | 16. Logan Draw          | 26. Shale Hill Ponds |
| 7. Hansen Creek (Kegley Draw) | 17. Meadow Creek        | 27. Centennial Park  |
| 8. Harrison Draw              | 18. Rosecrans windbreak | 28. Rankin Dam       |
| 9. Hayes Draw                 | 19. Rough Draw          | 29. Brown Reservoir  |
| 10. Jacob's Reservoir         | 20. Sandy Draw          | 30. Upton Clay Pits  |

- Monitored in 1992
- + Not monitored in 1992

Source: Douglas Ranger District Maps

FIGURE 3.47 WILDLIFE EXCLOSURES

**TABLE 3.13    RESERVOIRS AND WILDLIFE ENCLOSURES ON THE THUNDER BASIN NATIONAL GRASSLAND**

<b>Reservoir</b>	<b>Wildlife Enclosure</b>
Weston Reservoir	Little Powder Enclosure
Upton Centennial Reservoirs	Centennial Park Enclosure
Upton Bass Ponds	Upton Clay Pits Enclosure
Kellogg Reservoir	Kellogg Enclosure
Kettleson Reservoir	Kettleson Enclosure
Little Thunder Reservoir	Little Thunder Enclosure

## **AQUATIC BIOLOGICAL DIVERSITY**

### **Aquatic Ecosystem Structure, Process and Function**

The purpose of this section is to describe existing aquatic biological diversity on Thunder Basin National Grasslands (TBNG). Data displayed and discussed within this report was obtained from a variety of sources. It must be stressed however, that the amount of aquatic biota sampling on TBNG is very limited and some of the data used in this report is in excess of 15 years old. Despite this, the information is believed to reflect the types of aquatic organisms occurring there.

Data on amphibians was obtained from Wyoming Game and Fish Department, Baxter and Stone (1980), Douglas District Records and from surveys conducted by the Medicine Bow National Forest in the summer of 1992 (Rahel and Keleher, 1992). Fish population data was obtained from historical surveys conducted from the Wyoming Game and Fish Department University of Wyoming Water Center and the Medicine Bow National Forest. Wyoming Game and Fish lake and stream database was queried for more recent fish population data (within the last 15 years). No data was available. Fish population surveys conducted on several Thunder Basin reservoirs in 1992 by the Medicine Bow National Forest was also used. Macroinvertebrate data was obtained by conducting a literature search at the University of Wyoming and from United States Geological Survey (USGS). Information on the type and abundance of algae from selected streams within TBNG was also obtained from USGS. Further information on fish, amphibians and macroinvertebrates is in the Aquatic and Riparian Report (Speas, 1992).

Aquatic ecosystems on Thunder Basin have evolved over millions of years. Many factors can affect the structure, processes and function of aquatic ecosystems. Karr et. al., (1983) grouped these factors into the following 5 classes:

1. energy source - the type, amount and size of organic material entering a stream from the riparian zone verses primary production of the stream and the seasonal availability of those energy sources.

#### **Mechanism of impact:**

- \* decreased coarse particulate organic matter
- \* increased fine particulate organic matter
- \* increased algal production

2. water quality - temperature, turbidity, dissolved oxygen, nutrients, heavy metals and toxic substances, etc.

- \* expanded temperature extremes
- \* increased turbidity
- \* organic and inorganic chemicals, natural and synthetic
- \* heavy metals and toxic substances
- \* pH

3. habitat quality - diversity (pools, riffles), substrate type, water depth and velocity.

- \* substrate type
- \* water depth and velocity
- \* diversity (pools, riffles, woody debris)

4. flow regime - water volume, temporal distribution of floods and low flows.

- \* water volume
- \* temporal distribution of floods and low flows

5. biotic interactions - competition, predation, disease, parasitism.

- \* competition
- \* disease
- \* predation
- \* parasitism

The landscape pattern of a watershed including its regional topography, soil, vegetation types and land uses determine to a large extent the biological integrity of waterways. Human activities can alter the temporal and spatial landscape pattern and thus the biotas of streams and rivers. To a great extent, the impact of human activities vary among stream and other waterbodies based on their size and the magnitude of the impact. Despite this, these five classes of environmental factors that affect biota can work together to drastically alter ecological health of a watershed.

#### **Aquatic Species Composition**

##### **Algae**

Information on algae is sparse. United States Geological Survey have collected phytoplankton or periphyton data on six streams in TBNG. Diatoms are a algae in periphyton (algae attached to objects, such as rocks and logs) and phytoplankton (algae suspended in water) communities in the area, which usually dominate the communities in perennial streams. Green algae, blue-green algae, and euglenoids commonly dominate the periphyton and phytoplankton communities of ephemeral and intermittent streams, which represents the vast majority of streams on TBNG. Dominance of green and blue-green algae generally is considered to be a sign of organic enrichment whereas a relatively diverse diatom community generally indicates an enriched environment. No streams on TBNG receive sewage effluent, the commonness of green and blue-green algae is most likely the result of natural environmental conditions (e.g. high water temperatures) and fecal waste from livestock and wildlife.

##### **Amphibians**

Amphibians on Thunder Basin National Grasslands include salamanders, spadefoot, true toads, true and tree frogs (Table 3.10). The only

salamander on the Grasslands (tiger salamander) generally requires a moist environment but will inhabit both terrestrial and aquatic habitats during various stages of its life history. Neotenic tiger salamanders have been documented to occupy small fishless reservoirs on the TBNG (Rahel and Keleher, 1992). The plains spadefoot toad, Great Plains toad, and the Woodhouse's toad all inhabit neighboring grassland and/or sage brush communities. Breeding typically occurs in temporary water habitats with the exception of the Woodhouse's toad which is known to use perennial ponds associated with floodplains (Baxter and Stone 1980). Both species of frogs located on the Grasslands are found in or near permanent water. All amphibian species found on the Grasslands are considered common.

### **Fish**

All known fish species on Thunder Basin National Grassland are listed in Table 3.10. Twenty-three species are believed to be endemic to Thunder Basin National Grasslands streams. Additional species have been introduced to the area; the majority within impoundments and small stock ponds.

### **Macroinvertebrates**

Macroinvertebrate sampling within TBNG has been conducted by USGS, Wesche and Johnson (1980), and Wangness and Peterson (1980). Table 3.14 is a list of invertebrates collected from streams and reservoirs on TBNG. The major macroinvertebrate types expected in any streams throughout Thunder Basin are: snails (*Physa*, *Lymnaea*, *Gyraulus*), mayfly nymphs (*Caenis*), beetle larvae (primarily *Dubiraphia*), shrimp (*Hyallela azteca*), clams (*Sphaerium* and *Pisidium*), oligochaete worms and damselfly nymphs (primarily *Ischnura*). These invertebrates are common forms living in or near mud substrates of ponds, lakes and streams in much of the United States where organic debris is available as a food source (Hynes 1970; Pennak 1953). They are tolerant of a wide range of environmental conditions, including such things as high turbidities and temperatures, low dissolved oxygen and poor diversity of aquatic habitats.

### **Streams**

Streams on TBNG can be divided into 5 broad types each of which reflect specific fish assemblages (Wesche and McTernan, 1977). These categories are:

1. permanent clear water pools on ephemeral or intermittent streams
2. ephemeral pools on ephemeral streams
3. permanent turbid water pools on intermittent streams
4. turbid water perennial streams with deeply incised channels
5. turbid water perennial streams with less incised channels.

**TABLE 3.14 Taxonomic classification of macroinvertebrate benthic fauna from selected streams in Thunder Basin National Grassland.**  
(Data from Wesche and McTernan, 1977; Wangness and Peterson, 1980)

Order	Family	Genus
Diptera (two-winged flies)	Chironomidae	<i>Chironomus</i> sp. <i>Pentaneura</i> sp. --*
	Ceratopogonidae	<i>Palpomyia</i> sp. <i>Dasyhela</i> sp.
	Tabanidae	<i>Chrysops</i> sp. <i>Tabanus</i> sp.
	Culicidae	<i>Chaoborus</i> sp.
	Dolichopodidae	--
	Glossiphoniidae	--
	Stratiomyidae	
Coleoptera (beetles)	Elmidae	<i>Dubiraphia</i> sp.
	Hydrophilidae	<i>Berosus</i> sp.
	Dytiscidae	<i>Hydaticus</i> sp. --
	Halipilidae	<i>Halipilus</i> sp. --
Ephemeroptera (mayfly)	Caenidae	<i>Caenis</i> sp.
Odonata (damselfly and dragonflies)	Coenagrionidae	<i>Ischnura</i> sp. <i>Argia</i> sp.
	Libellulidae	<i>Somatochlora</i> sp.
	Gomphidae	<i>Gomphus</i> sp.
	Aeshnidae	<i>Aeshna</i> sp.
Tricoptera (caddisfly)	Psychomyiidae	<i>Polycentropus</i> sp.
	Lymnephilidae	<i>Lymnephilus</i> sp.
	Phryganeidae	<i>Phryganea</i> sp.
	Hydropsychidae	<i>Cheymatophysche</i> sp.
Hemiptera (water bugs)	Corixidae	--
	Gerridae	--
	Veliidae	<i>Microvelia</i> sp.
Amphipoda (shrimp)	Talitridae	<i>Hyallela azteca</i>
Hydracarina (water mites)	Limnochareidae	<i>Limnochares</i> sp.
Oligochaeta (worms)	Tubificidae	--
Hirudinea (leeches)	Glossiphoniidae	--
Pulmonata (snails)	Physidae	<i>Physa</i> sp.
	Planorbidae	<i>Gyraulus</i> sp.
	Lymnaeidae	<i>Lymnaea</i> sp.
	Ancylidae	<i>Ferrissia</i> sp.
Sphaeriacea (clams)	Sphaeriidae	<i>Sphaerium</i> sp.
Megaloptua (hellgramites)	Sialidae	<i>Sialis fuliginosa</i>

Shannon-Weaver Diversity Index values and stream condition are based on Magnum (1975). Biological diversity of each habitat type is discussed below.

<u>Diversity Index</u>	<u>Stream Condition</u>
3-4	Excellent
2-3	Good
1-2	Fair
<1	Poor

#### **Habitat Type 1**

On permanent, clear water pools on ephemeral or intermittent streams, fish communities are variable depending upon whether game fish have been introduced. Fish communities within these habitats tend to be some of most diverse on the TBNG with an excess of 6 species present. On perennial reaches of Little Thunder Creek, carnivores such as green sunfish, largemouth bass and bluegill have been collected. These introduced predators are believed to have originated from reservoirs existing within the drainages. The only endemic predator collected from streams having permanent clear water pools are black bullhead. Herbivores such as fathead minnow exist in variable numbers depending upon the proportion of predators within the local community. Omnivores such as sand shiner and white sucker exist in lower numbers and constitute less than 20 percent of the community composition. All of the fish taxa collected in these habitat types have an intermediate to high tolerance to non-point or point pollution.

Macroinvertebrate communities in permanent clear water pool habitats are some of the most diverse on the TBNG, with over thirty taxa. Freshwater snails (primarily *Physa* and *Lymnaea* typically dominate by numbers and biomass). Other taxa that commonly appear in samples include freshwater clams (*Pisidium*), freshwater shrimp (*Hyallela azteca*), midge larvae (Chironimids) mayfly numphs (*Caenis*), and at least three species of caddisflies.

The presence of aquatic vegetation, more stable substrate and typically less turbid water conditions in this habitat type, provide conditions for a greater abundance of invertebrates than the other aquatic habitat types. Macroinvertebrate diversity values range from 2.0 to 2.5 indicating high-fair to low-good stream condition.

#### **Habitat Type 2**

On ephemeral pools on ephemeral streams fish communities are not diverse and generally composed of three or less species. On areas in which fish population data has been collected (e.g. School Creek), white suckers dominate both numbers and biomass. Black bullhead and fathead minnows exist in lower numbers. The reduced diversity of fish species is most likely attributed to extensive channel dewatering.

During late summer, only shallow pools with poor water quality remain within these habitat types.

The ephemeral pool and ephemeral stream habitat type has twenty-two macroinvertebrate taxa. Freshwater snails constitute the predominant taxon. Other taxa include Chironomid larvae, oligochaetes and caddisfly larvae. Wesche and Johnson (1980) found the general trend for macroinvertebrates in such habitats was for lower biomass and numbers in spring and early summer with increase peak annual concentrations in fall and winter. He hypothesized these fluctuations to result from adaptations in invertebrate life history patterns which cope with the intermittency of water supply. This strategy involves overwintering in the late stages of larval development, followed by emergence of adults in the spring to coincide with periods of runoff. Adults reproduce when the availability of water insures both hatching success and distribution of the species. Under such extreme conditions, diversity of macroinvertebrates is low and diversity values range from 0.5 to 1.5, indicating stream conditions from poor to high-fair.

### **Habitat Type 3**

Permanent, turbid water pools on intermittent streams probably constitute the vast majority of fish bearing streams on the TBNG. Lower reaches of Antelope Creek and much of the Cheyenne River within the Grasslands contain this type of habitat. Fish communities are again variable but are less diverse than areas on Antelope Creek where permanent clear water pools exist. Sand shiners and fathead minnows dominate these fish communities. These fish represent both herbivorous and omnivorous trophic classes. Flathead chub and plains killifish are carnivorous species within these habitats. Both species feed primarily on insects while flathead chub also feed on small fish.

Nineteen macroinvertebrate taxa have been collected from permanent, turbid water pools on intermittent streams. These stream types have aquatic faunal assemblages similar to streams with ephemeral pools. An example is the intermittent reaches of Antelope Creek near its confluence with the Cheyenne River, and the Cheyenne River main trunk). Freshwater snails (*Physa*) are the most abundant by number. Chironomid larvae, Dipteran larvae, mayfly larvae, freshwater clams and oligochaete worms are commonly found in these habitats. Numbers of individuals tend to be low. Diversity values range from 1.5 to 2.0, indicating high-fair stream conditions.

### **Habitat Type 4**

Perennial reaches, with turbid water pools and a deeply incised channel, are another habitat type on the Grasslands. Examples are reaches of Little Powder River upstream of Weston, Wyoming and Beaver Creek within the grasslands boundary. Eleven species have been collected from these habitat types. Sand shiners (omnivore) and fathead minnows (herbivore) comprise the greatest proportion of the fish species collected in Little Powder by number (> 95 percent).

Carnivores include black bullhead and green sunfish. The latter of which have been introduced within many areas in both drainages. Carnivores comprise less than 3 percent of the populations sampled. White sucker (omnivore) and northern redhorse (omnivore) have been collected in the Little Powder River near Weston. These seem to be transitory.

Macro-invertebrate communities in turbid-water pools in deeply incised perennial streams tend to vary more with seasonality than do invertebrate communities in other habitat types. For example, macroinvertebrate sampling conducted by USGS and Wesche and McTernan (1977) revealed that beetle larve (*Dubiraphis*) were most abundant in the spring on reaches of the Little Powder River near Weston, Wyoming. In fall and winter, Chironomid larvae were most abundant. Freshwater snails (*Lymnae* and *Physa*) and oligochaete worms were abundant throughout the year. Other taxa sampled in these habitat types include mayfly numphs (*Caenis*), alderfly larvae (*Sialis*), water mites (*Neumania*) and giant water beetles (*Belastoma*). At least nineteen taxa have been collected from this habitat type. Species diversity values range from less than 1.0 in the spring to 1.0 - 1.5 in the fall. These range indicate low-fair conditions.

#### **Habitat Type 5**

The final stream habitat type existing on Thunder Basin National Grassland is turbid water pool on perennial streams with less severely incised channel. Examples of a stream which contains these habitat types are lower sections of the Little Powder River near Weston, Wyoming. A total of 9 species have been collected at one time or another on this section of stream. Fish populations tend to be highly variable however due to the natural movement of fish into and out of these stream sections. Carnivores occurring in these waters are black bullhead, flathead chub, green sunfish, goldeye and stonecat. Carnivores represented less than 15 percent of the fish communities sampled. Omnivores such as sand shiner and white sucker and northern redhorse comprise the highest percentage (> 60%) of the community followed by herbivores such as fathead minnow, plains minnow, and river carpsucker. As in other sections of the Little Powder River, northern redhorse are in low numbers and appear to be transitory to the area. Goldeye is considered rare by Wyoming Game and Fish Department.

Similar trends in macroinvertebrate communities for perennial reaches with turbid water pools along deeply incised channels are also seen on perennial reaches less deeply incised. Chrionomid larvae are the most abundant year-round and beetles are numerous. Caddisflies, mayflies and dragonflies have also been collected, but generally occur in low numbers. At least twenty-one taxa have been collected from this habitat type.

## **Reservoirs**

Reservoirs on the Grasslands can be categorized into 3 groups based on their ability to support fish populations. Two of these types (warmwater and coldwater) support fish. The third type does not.

Warmwater fisheries reservoirs typically contain largemouth bass, green sunfish, black bullhead and in some instances white sucker and common carp. These reservoirs usually thermally stratify during the summer months with deeper portions of these reservoirs becoming anoxic (lacking oxygen). Alkalinities are moderate to high as is hardness. Cold water fisheries are much fewer in number than warmwater fisheries and usually contain brook or rainbow trout. These reservoirs are usually spring fed, deep (>15 feet), and contain hard waters. Despite their depth, many of the cold water reservoirs are susceptible to winter kill. The last type of reservoir existing on the Grasslands are fishless. These reservoirs historically supported fish populations but have filled from sediment produced from the drainage. Turbidities are high unless sufficient aquatic vegetation has developed to stabilize the shoreline. In instances where sufficient shoreline vegetation has developed, these reservoirs have developed into excellent wetlands. Amphibians such as leopard frogs and tiger salamanders utilize these habitats.

Benthic invertebrate communities are similar for fishless and fish-bearing reservoirs. Snails, midge larvae, dragonfly and damselfly larvae and amphipods typically occur. Zooplankton typically consist of copepods, cladocerans (water fleas) and corixid beetles. Zooplankton in fishless reservoirs generally have large body size because of lack of predation by fish.

## **HISTORICAL CONSIDERATIONS FOR BIOLOGICAL DIVERSITY**

The Thunder Basin National Grassland is one of many areas purchased by the Federal Government beginning in 1934 under the Agricultural Adjustment Administration. These lands were acquired by the government during the drought period of the 1930s to enable rehabilitation programs primarily involving erosion control and the return of cultivated lands to range uses.

The lands were transferred to the U. S. Forest Service in 1954 and the Thunder Basin National Grassland became an official unit of the Medicine Bow National Forest in 1960.

A biological diversity assessment must consider the history of the land, because the present state of biological diversity (the full variety of life on the landscape) is a function not only of evolution and environmental constraints, but also of land use history and changes effected by the settlement of the west beginning in the mid 1800s.

The present composition of species, the pattern of plant communities on the landscape, and successional states of these communities has been changed from its presettlement condition because of direct and indirect effects of modern human presence (Cooperrider, 1991). Presettlement

data for plant community composition and structure or wildlife populations and distribution does not exist for the Thunder Basin National Grassland, or for other areas in the Great Plains or Intermountain West, but it is generally recognized that the widespread and pervasive forces of livestock grazing, fire suppression, predator control, herbicide and pesticide spraying, introduction of exotic plants and noxious weeds, water diversion and impoundment projects have caused change. More recently, coal extraction has added a new dimension to biological diversity through total removal of patches of landscape and reclamation of those areas into new landforms reclaimed by reseeding with both native and introduced species.

The effects of these activities are difficult to quantify. Many have caused the alteration or loss of distinct populations or communities. In some cases, for example the bison and black-footed ferret, entire species have been extirpated from their historical range. Alterations of natural ecosystems are less easy to detect and determination of the range of natural variability is more difficult to determine in a grassland or steppe environment than in a forested environment because the effects of change are not as obvious. Grasses or forbs readily recolonize damaged areas and the constant effects of livestock grazing and wildlife use often prevent the establishment and survival of shrub or tree species which would normally form later seral stages. Without fenced exclosures and monitoring data, it is only possible to infer what communities of plants and animals would be present without existing grazing and/or wildlife herbivory. Few studies have been conducted on landscape scale effects of fire suppression in steppe environments in the United States. To the best of our knowledge, no studies have ever been done on the Thunder Basin National Grassland on the effects on biological diversity of the other human-induced activities cited above.

Livestock grazing, prairie dog control by poisoning , shooting, herbicide application to control sagebrush, fire suppression and bounty hunting of predators are specific human activities which directly affect biological diversity by impacting specific populations or by having landscape-wide effects on energy flow, plant species composition and structure and nutrient cycling.

Six areas containing long-term study sites, designed to evaluate the recovery of vegetation after the 1930s drought years, were established in 1936. Each site was 1 square mile in size, and the sites were located in different vegetation types according to the criteria at the time. Iron pipes, placed 0.1 mile apart formed a permanent sampling grid on each site. Species composition and cover was read for a 100 square foot area around each pipe from 1936 until 1943, again in 1965 (Lang, 1973) and they are currently being read again by researchers from the University of Wyoming and the University of Idaho (Fisser et al, 1989). Exclosures were placed at each site between 1941 and 1943.

Lang's evaluation in 1965 on five of the six areas revealed that blue grama (shortgrass) had increased and western wheatgrass, needleandthread and junegrass (midgrasses) had decreased since 1943 on four of five sites which were unplowed rangeland. The previously

farmed site was heavily grazed and there was less perennial grass cover in 1965 than in 1943. Big sagebrush and cactus had both increased both inside and outside of exclosures. The 1987 study (Fisser et al, 1989) on one site, indicated that grass cover had increased threefold and sagebrush and other woody shrubs had increased four-fold since 1936. Cactus cover increased almost nine-fold.

Aquatic systems have been greatly altered with the loss of much of the riparian cottonwood forest and riparian shrublands of larger streams, the building of reservoirs, increased sedimentation and the introduction of alien fish species. A salient discussion of biological diversity and aquatic management is in Williams and Neves (1992).

The historical considerations are discussed here because biological diversity is a dynamic property of ecosystems at all scales. It has been changed in the past, and it can be changed in the future. We are only beginning to understand the enormity of change that has been brought about by human activities.

#### **LANDSCAPE MODELS, DISTURBANCE AND BIOLOGICAL DIVERSITY**

Past models of plant community successional behavior have been based on the succession and climax theory proposed by Clements in 1920 in his classic work on plant succession. Over the years, this linear model of plant community behavior has almost achieved the status of natural law among range managers and its concept and terminology have been incorporated into National Forest Plans for evaluation of vegetation (Moir, 1989).

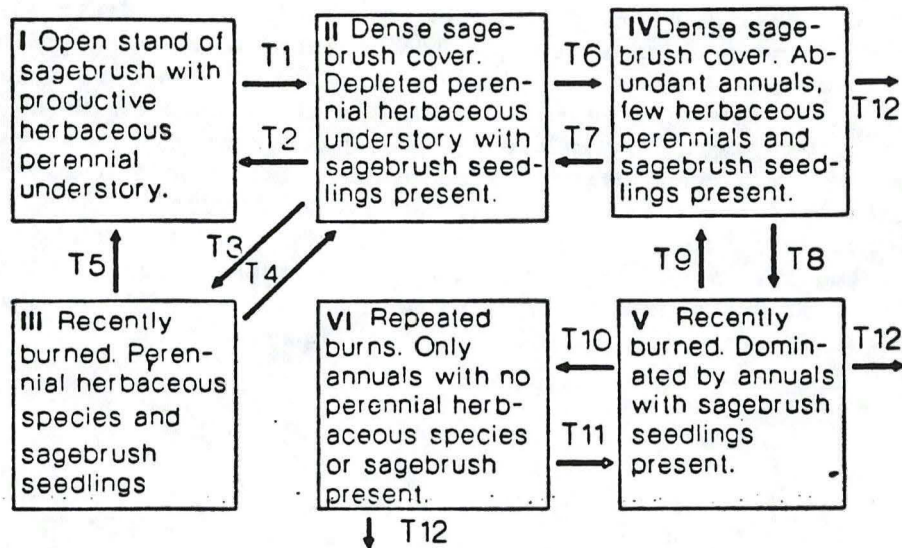
The climax model assumes that plant communities replace each other over time in an orderly fashion called progression. The stages are called early, mid or late seral stages to describe their relative positions between a denuded state and a climax state. The final community in the series, which will self-perpetuate, is called the climax community. It is also known as potential natural vegetation and is described by a particular community type called a plant association. The progressive succession of communities can be reversed (retrogression).

This occurs in the presence of some factor (such as grazing) which presumably moves the communities backwards through succession. Disturbances such as fire or plowing can move the system to an earlier seral stage, but it is assumed that the ecosystem will continue to progress toward the late seral or climax stages.

Another model of vegetation behavior, developed mostly in Australia after several decades of research on arid and semiarid desert, grassland and shrubland, is called the state and transition model (Westoby et al, 1989). Seral stages are recognized in these models, but there can be multiple stable states and application of some forceful event (fire, seeding) may be needed to transition between the stable states. A state-and-transition model for a sagebrush-grass ecosystem type has been proposed recently by Laycock (1991). This model is presented in Figure 3.48.

# STATE-AND-TRANSITION MODEL FOR A SAGEBRUSH GRASS ECOSYSTEM

(After Westoby, Walker and Noy-Meir, 1989)



**Fig. 3. State-and-transition diagram for sagebrush-grass vegetation.**

## Catalogue of Transitions

**Transition 1**—Heavy continued grazing. Rainfall conducive for sagebrush seedlings.

**Transition 2**—Difficult threshold to cross. Transitions usually will go through T3 and T5.

**Transition 3**—Fire kills sagebrush. Biological agents such as insects, disease or continued heavy browsing of the sagebrush by ungulates could have the same effect over a longer period of time. Perennial herbaceous species regain vigor.

**Transition 4**—Uncontrolled heavy grazing favors sagebrush and reduces perennial herbaceous vigor.

**Transition 5**—Light grazing allows herbaceous perennials to compete with sagebrush and to increase.

**If climate is favorable for annuals such as cheatgrass, the following transitions may occur:**

**Transition 6**—Continued heavy grazing favors annual grasses which replace perennials.

**Transition 7**—Difficult threshold to cross. Highly unlikely if annuals are adapted to area.

**Transition 8**—Burning removes adult sagebrush plants. Sagebrush in seed bank.

**Transition 9**—In absence of repeated fires, sagebrush seedlings mature and again dominate community.

**Transition 10**—Repeated burns kill sagebrush seedlings and remove seed source.

**Transition 11**—Difficult threshold to cross if large areas affected. Requires sagebrush seed source.

**Transition 12**—Intervention by man in form of seeding of adapted perennials.

Thorough exploration of this concept is beyond the scope of the biological diversity assessment. This information is presented here as a beginning for discussion of the relationship of successional states to biological diversity. The Medicine Bow National Forest Plan has management criteria regarding "horizontal diversity" (successional stages) and also vertical diversity (which is a structural attribute of plant communities and may vary with succession among herbaceous, shrub and tree communities). For this report, it is sufficient to point out that models of successional behavior are important to the interpretation of descriptions of biological diversity and the formulation of management goals for the desired future condition of biological diversity. The landscape mosaic of the Thunder Basin National Grassland is very complex at the community level which is most directly related to projects and management.

## **CHAPTER IV**

### **AREAS WITH SPECIAL BIOLOGICAL DIVERSITY CHARACTERISTICS**

#### **CRITERIA FOR AREA IDENTIFICATION**

The descriptions and general discussion of the overall biological diversity characteristics of the Thunder Basin National Grassland presented in Chapter 3 form the basis for the identification of areas with special biological diversity characteristics. Identification of these areas containing uncommon or specialized plant and animal communities with their attendant ecosystem processes and functions, will facilitate development of special ecosystem management considerations which are expected to maintain biological diversity characteristics.

Criteria for identifying areas with special biological diversity characteristics are listed below according to scale, and available information on composition, structure, process and function. These criteria include providing special consideration for: uncommon communities and landscapes; communities and landscapes which are believed to contain sensitive ecosystems; and communities and landscapes which contribute significantly to the mix of biological communities on the Thunder Basin National Grassland.

#### **Scale criteria**

##### **Landscape scale (Coarse Filter Approach)**

- Patch and/or corridor size
- Patch and/or corridor composition and structure characteristics (community composition, vertical and horizontal diversity)
- Patch and/or corridor position in the matrix
- Degree of isolation of patch or corridor
- Estimated coupling of communities within patch or corridor
- Estimated sensitivity of the patch or corridor to change and recovery (resistance and resilience of the whole system)
- Existing landscape ecological integrity of the patch and/or corridor (Degree of existing fragmentation and human influences)
- Quality of animal habitat provided by plant communities in the landscape context
- Ecosystem management direction from the Regional and Washington Offices

##### **Community scale (Coarse Filter Approach)**

- Kinds of plant and animal communities
- Spatial relationship and size and plant and animal communities
- Condition of plant and animal communities (Existing community ecological integrity and seral stage condition)

#### **Species scale (Fine Filter Approach)**

- Plant and animal species richness
- Plant and animal species with specialized or restricted habitat requirements
- Plant and animal species with small populations or low potential for population increase

#### **Genetic scale (Fine Filter Approach)**

- Barriers to movement of individuals or populations
- Factors which may increase the background mutation rate
- Factors which may exterminate or decrease populations which are isolated or have low numbers of individuals.

#### **Composition, Structure, Process and Function Criteria**

- Landscape and Community Scales (Coarse Filter Approach)
  - Provision of integrated communities types in specialized, unique landscape patches
  - Maintenance of future options for management of environmentally sensitive areas
  - Provision of current protection against unknown effects for small landscape patches, where intrusions from oil and gas leasing activities and subsequent increased human presence will be likely to cause more impact than on large matrix areas.
- Species and Genetic Scales (Fine Filter Approach)
  - Protection of complexity and interaction of habitat characteristics so that species existing in isolated patches or with special requirements can continue to maintain viable populations.

Vegetation with greater spatial continuity provides a more valuable reservoir for biological diversity than small areas with special management for specific species. However, both approaches (Coarse and Fine Filter) have roles as ecosystem management strategies which recognize and perpetuate the biological diversity of particular National Forest management units.

The effects of fragmentation are difficult to assess because they vary with scale; with the needs of species; and with cumulative effects on ecosystem processes and functions. Attributes of fragments include density, isolation, size, shape, aggregation and boundary characteristics. The primary impact of fragmentation at any scale is loss of habitat continuity (Lord and Nelson, 1990).

Although data on the specific effects of fragmentation are sparse for Thunder Basin National Grassland ecosystems, there is a body of scientific studies on many other systems that indicate how complex systems are more likely to be disrupted at a given scale of fragmentation than simpler systems (Harris, 1984; MacArthur and Levins, 1964; Pickett, S.T.A. and P. S. White, 1985; Saunders et al, 1987; and Wilcove et al, 1986). This was an important consideration in identifying areas on Thunder Basin National Grassland needing special biological diversity consideration. Patches of specialized vegetation, and riparian systems have more complexity in a small area than the

matrix and are therefore expected to be more sensitive to both known and unknown effects of fragmentation than the matrix.

#### **AREAS WITH SPECIAL BIOLOGICAL DIVERSITY**

The results of the analysis revealed that species richness (numbers of species), as an indicator of biological diversity, should only be one factor considered in evaluating the importance of an area for special management consideration. Some areas which have low species diversity and/or numbers contribute significant biological diversity to the Thunder Basin National Grassland at the community and landscape levels because they have species whose populations, patch size or territories are small and/or whose ecological requirements are highly specialized.

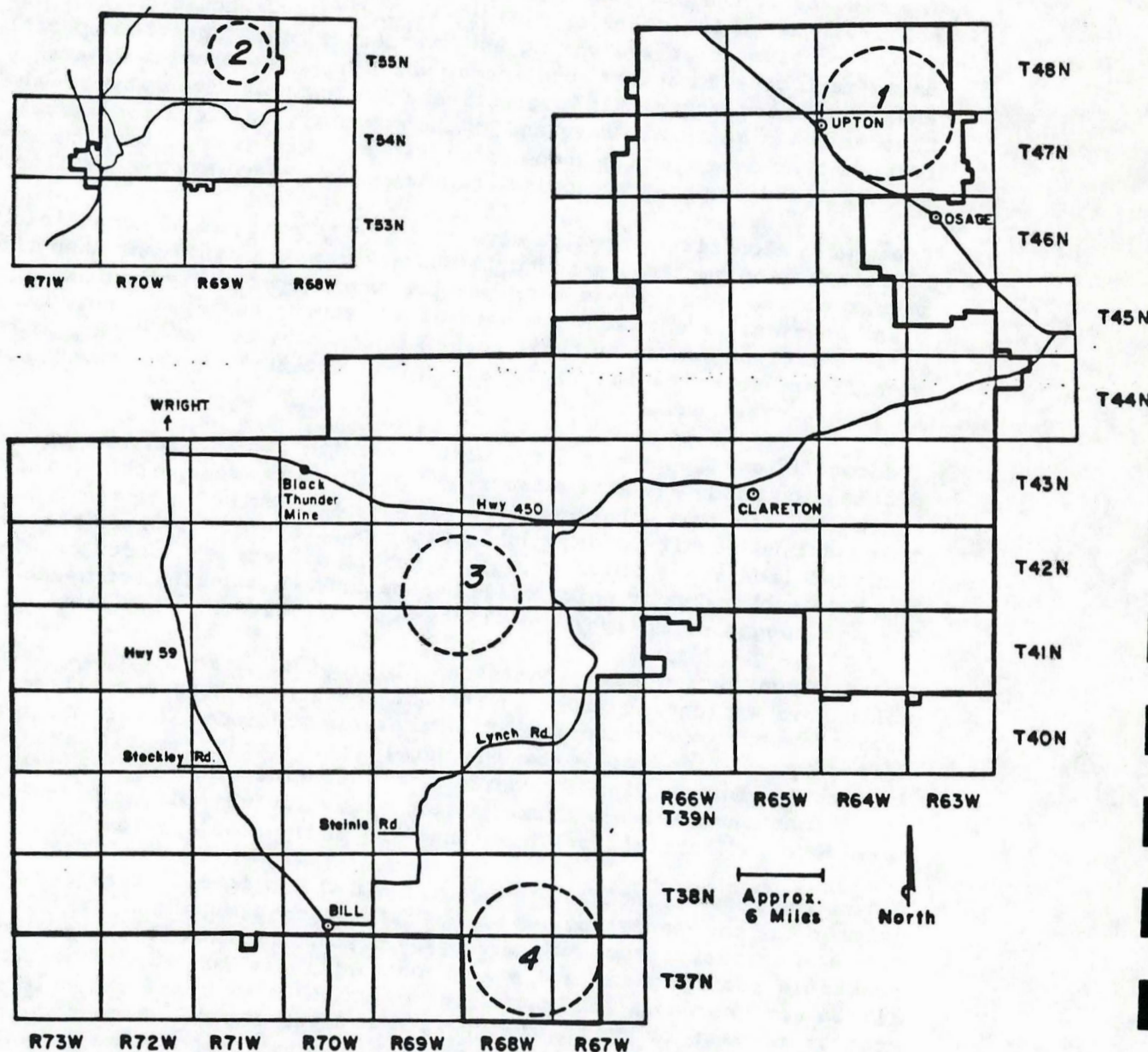
Areas with significant species diversity; areas with patches containing horizontal and vertical structural characteristics different than the matrix of the area; areas with patches where specialized animal and plant species, or uncommon communities are found; and areas where many different plant community types occur in proximity to one another, make significant contribution to the biological diversity of Thunder Basin National Grassland.

The condition of specific areas with regard to impacts from livestock grazing and roads was also a factor for evaluating areas with important biological diversity characteristics. Some attributes which contribute to good land condition and high quality habitat for wildlife species included land areas which: 1. lack public access; 2. occur on clay or shale substrates on which roads become unuseable during wet weather; 3. have rugged topography and 4: have good livestock management.

Other places which have significant biological diversity are lands which have wetland or riparian characteristics. These are all small patches or narrow corridors, and the analysis concluded that biological diversity in these could be adequately protected from oil and gas impacts by Forest Plan Standards and Guidelines and by the siting conditions in the lease terms. Such areas include playas, riparian corridors and habitat for Threatened and Endangered species.

All of the areas identified as having special biological diversity form patches in the landscape matrix of sagebrush steppe and grassland. They are characterized, as a group, by discontinuities in the geologic substrate and by plant and animal communities which represent range limits or remnants of communities which are characteristic of ecosystems east or north of the Powder River Basin, which occur on substrates which are limiting to plant species composition or which contain animal specialists which need communities occurring as islands in the matrix.

Figure 4.1 shows the location and character of the patches which are considered to have special biological diversity characteristics. Riparian corridors and patches also have special biological diversity characteristics, but are not included as specific areas for special management with regard to Oil and Gas Leasing because they already have special management under Forest Plan Standards and Guidelines, EPA



**FIGURE 4.1 AREAS WITH SPECIAL BIOLOGICAL DIVERSITY CHARACTERISTICS**

1. Upton-Osage area: woodland-sagebrush mosaic
2. Duck Creek Breaks: woodlands, woody draws, aspen groves, and tallgrass prairie remnants
3. Rochelle Hills: woodland-grassland mosaic
4. Miller Hills, Cow Creek Buttes and Downs Area: scoria buttes, sandstones, clay and shale badlands, shrubland-woodland mosaic

Regulations, Wyoming State Water Quality Standards and standard oil and gas lease terms.

The general areas with special biological diversity characteristics are:

1. The landscape of the Upton-Osage area which includes the woodland-sagebrush mosaic on Cretaceous sandstones, limestones and shales
2. The landscape of the Duck Creek Breaks which includes the mosaic of woodlands, woody draws, tall grass prairie remnants, aspen and a variety of grassland and shrub-steppe communities on primarily sandstone substrates
3. The Rochelle Hills landscape which includes a woodland-grassland mosaic on sandstone and scoria substrates
4. The landscape complex formed by the Miller Hills, Cow Creek Buttes and Downs Area which includes major scoria buttes, sandstones and the clay and shale badlands formed by eroding Lebo Formation deposits. These areas collectively form landscapes with distinctive biological diversity based in the large number of plant communities which occur on diverse substrates.

#### **SPECIAL STIPULATIONS AREAS AND BIOLOGICAL DIVERSITY**

Three kinds of Special Stipulations were identified in Alternatives 3 and 4 of the DEIS. These are: Controlled Surface Use; Timing Limitations; and No Surface Occupancy. Controlled Surface Use stipulations limit road densities and provide for stricter controls on surface disturbance than standard lease terms; Timing Limitations are designed mainly to protect isolated small patches for wildlife nesting or breeding sites; No Surface Occupancy can reserve an array of patch sizes from oil and gas development.

The special stipulations were developed primarily for protection of specific wildlife habitat needs and recreation values. Many of the areas identified in the DEIS for application of special stipulations for recreation, wildlife or soil mass wasting protection were also identified as having special biological diversity characteristics.

Land attributes such as scenic value, quality wildlife habitat, tree and shrub cover and plant community diversity which create value for recreation in the Thunder Basin National Grassland landscape are intimately linked to the biological diversity characteristics discussed earlier. In particular, four of the five Inventoried Semi-Primitive Motorized Areas identified through the Recreational Opportunities Spectrum Process for the DEIS were also found to have biological diversity characteristics which could only be perpetuated by No Surface Occupancy stipulations protecting the existing ecological integrity. Recommendations for use of special stipulations to perpetuate biological diversity on these and additional areas are in Chapter 7.



## CHAPTER V

### ENVIRONMENTAL CONSEQUENCES TO BIOLOGICAL DIVERSITY FROM OIL AND GAS LEASING

#### GENERAL CONSIDERATIONS

It should be emphasized that the Oil and Gas Leasing EIS is a document that considers environmental, social and other consequences of leasing. Lands available for leasing, are discussed in the DEIS. Please consult the DEIS for more information on the need for oil and gas leasing, the history of past use patterns and a full discussion of Alternatives. Other specialist reports include information on impacts to specific resources such as threatened and endangered species, aquatic and riparian systems, soil and water resources (Byer and Cartwright, 1992; Cartwright, 1992; Speas, 1992; Edwards, 1991).

The environmental consequences to biological diversity from oil and gas leasing must be considered for each scale of biological diversity (landscape, community, species and genetic). Environmental consequences from oil and gas leasing must address impacts on composition, structure, process and function at each scale. Knowledge of direct and indirect environmental effects is minimal to absent for some components of biological diversity. Data with adequate temporal and spatial characteristics to predict and evaluate change is lacking for landscapes and communities (Coarse Filter levels). Changes in these systems may be subtle and not be evident immediately.

Direct and indirect effects at the landscape scale are primarily on the integrity of whole ecosystems consisting of multiple plant communities; on habitat for wide-ranging species; and portions of aquatic ecosystems where chemicals or sediments tend to accumulate. At the community and species scales impacts of oil and gas leasing are on specific vegetation communities and individual species of plants and wildlife. These impacts will vary according to the life cycle requirements of particular species and the role they play in the structure, process and function of communities with which they interact. Both terrestrial and aquatic species can be affected.

Genetic biological diversity of plant or animal species is not expected to be altered or impacted adversely under any of the Alternatives because there are no significant destabilizing effects on populations, barriers to movements of individuals which might adversely interrupt gene flow, isolating effects, or production of chemicals which would increase the background mutation rate. Gene flow among plant and animal populations is expected to continue at a level which will maintain the present levels of biological diversity if populations are maintained.

## ANALYSIS OF THE ALTERNATIVES

The continued leasing Alternatives (1, 2, 3, 4 and 6) differ in the degree to which exploration and development would be allowed. Alternative 5 (No new leasing) would result in the eventual discontinuation of oil and gas leasing as existing leases expire. Direct and indirect impacts apply to all the alternatives with continued leasing.

It is expected that up to 20 wells per year would be constructed under any of the continuing lease alternatives (1,2,3,4 and 6). This would cause an estimated direct disturbance of 20 to 50 acres per year. A summary of the Alternatives with regard to leasing and special stipulations imposed for No Surface Occupancy (NSO); Controlled Surface Use (CSU) or Timing Limitations (TL) as presented in the DEIS is below.

**Alternative 1: (No Action)** About 320 acres at the Walker Teepee Ring Archaeological Site would be placed under the NSO stipulation. All other areas would be available for leasing under Forest Plan direction. Special protection is provided for nesting and breeding grounds of selected wildlife indicator species, Threatened and Endangered Species and other special interest wildlife species through Forest Plan Standards and Guidelines and Federal Endangered Species Laws.

**Alternative 2: (Leasing with standard and special stipulations)** About 320 acres at the Walker Teepee Ring Archaeological Site would be placed under the NSO stipulation. Additional smaller sites would be placed under NSO, CSU or TL stipulations for reasons of soil mass wasting or habitat protection for nest sites, breeding sites or critical time periods for wildlife. (Map for Alternative 2 - Appendix E DEIS)

**Alternative 3: (Leasing with standard and special stipulations, recreation emphasis).** About 320 acres at the Walker Teepee Ring Archaeological site would be placed under the NSO stipulation. No acres would be placed under CSU for reasons of recreation but about 15,693 acres would have an NSO stipulation applied to Inventoried Semi-Primitive Areas at Cow Creek Buttes and the Miller Hills. About 33 acres of waterbodies in existing reservoirs would be placed under a CSU stipulation. Additional smaller sites would be placed under NSO, CSU or TL stipulations for reasons of soil mass wasting or habitat protection for nest sites, breeding sites or critical time periods for wildlife. (Map for Alternative 3 - Appendix E DEIS and Revisions to ISPM-NSO Areas after the DEIS).

**Alternative 4: (Leasing with standard and special stipulations, greater recreation emphasis).** About 320 acres at the Walker Teepee Ring Archaeological Site would be placed under the NSO stipulation. About 53,639 acres would be placed under the CSU stipulations for recreation and about 24,304 acres would have an NSO stipulation for Inventoried Semi-primitive Areas at Cow Creek Buttes, the Miller Hills and Duck Creek. About 33 acres of waterbodies in existing reservoirs would be placed under a CSU stipulation. Additional smaller sites would be placed under NSO, CSU or timing limitations for reasons of soil mass wasting, protection for nest sites and breeding sites or critical time

periods for wildlife. (Map for Alternative 4 - Appendix E DEIS and Revisions to ISPM-NSO Areas after the DEIS).

**Alternative 5: (No new leasing).** Special stipulations are applicable only to new leases. No special stipulations would be needed because no new leases would occur. Forest Indicator species, Threatened and Endangered Species and other selected wildlife species would continue to receive protection under Forest Plan Standards and Guidelines.

**Alternative 6: (Leasing with standard and special stipulations only).** About 320 acres at the Walker Teepee Ring Archaeological Site would be placed under the NSO stipulation. Threatened and Endangered Species would be protected by laws pertaining to the Endangered Species Act. Forest Plan Standards and Guidelines would be met only to the extent allowed with standard lease stipulations. Thus, no special consideration or protection would be offered to indicator species, Candidate species or other wildlife species under this Alternative.

The features of these Alternatives that interact with biological diversity considerations are:

1. The location and number of acres available for leasing.
2. How many acres are affected by special stipulations (NSO, CSU or Timing Limitations) which may eliminate or reduce impacts from oil and gas leasing activities.
3. The relationship of areas recommended for special stipulations (NSO, CSU or TL) for reasons of soil mass wasting, archaeology, or wildlife nesting, breeding or critical timing, to:
  - a. landscape patches or corridors with important or unique biological diversity characteristics;
  - b. communities with unique species composition or sensitive processes and functions;
  - c. species with small populations, specialized habitat or parts of their life cycle sensitive to disruption by indirect, direct or cumulative effects of oil and gas leasing.

On a general scale the continued leasing Alternatives (1,2,3,4 and 6) can be ranked from the most to the least direct and indirect impacts on biological diversity as follows. The criterion used is numbers of acres in each Alternative which limit or prohibit oil and gas exploration and development for both large areas (Coarse Filter level) and individual species (Fine Filter level).

<b>Most</b>	5 - leasing with standard stipulations only
	1 - leasing consistent with the Forest Plan (No Action)
	2 - leasing with standard and special stipulations consistent with the Forest Plan
	3 - leasing with standard and special stipulations-recreation emphasis

**Least            4 - leasing with standard and special stipulations, greater  
                         recreation emphasis**

Alternative 5 (No new leasing) may have more short-term impacts because of possible intensified activity before leases expire. Since most of the Thunder Basin National Grassland is currently under lease, these impacts could be substantial if increased exploration and drilling should occur in the near future prior to lease expiration. These impacts could also occur for all other alternatives also.

The scenario for impacts to biological diversity also varies with the likelihood of oil and gas development. The pattern of occurrence of oil and gas plays in upper or lower Cretaceous, or Permian-Pennsylvanian strata a mile or more below the present surface, has no relationship to the patterns on the modern landscape. Known patterns of oil and gas fields, the patterns of producing wellfields and dry hole areas, and the reasonable foreseeable development model developed for the Gas and Oil EIS are shown in Figures 5.1 - 5.6.

These maps are drawn to the same scale as the maps for vegetation, geology, and wildlife distribution presented earlier. The degree of impacts of oil and gas development on biological diversity varies among alternatives as shown above. It also varies with the probability of development as that relates to specific areas and their characteristics of biological diversity.

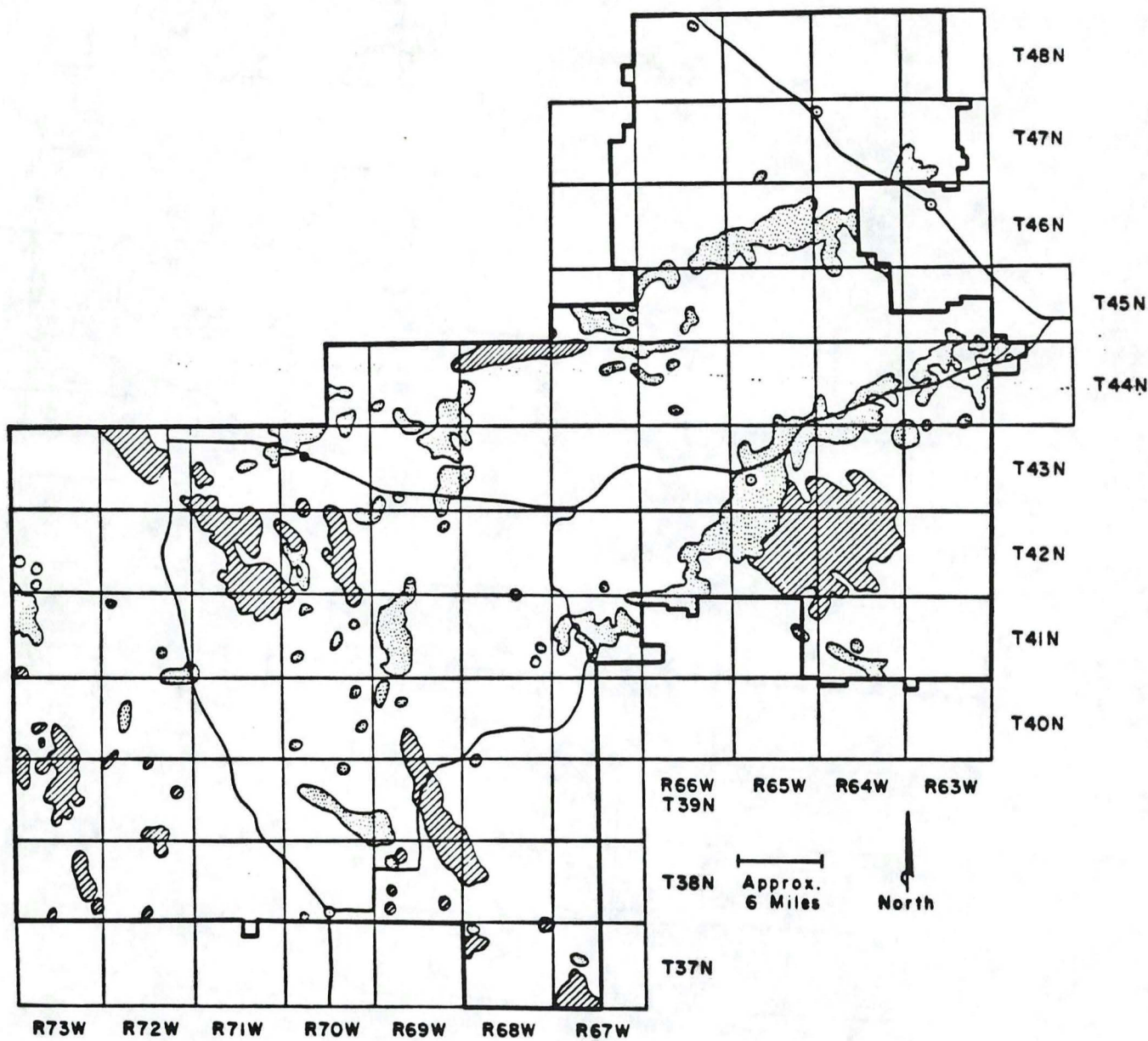
#### **DIRECT AND INDIRECT IMPACTS ON BIOLOGICAL DIVERSITY ON THE LANDSCAPE AND COMMUNITY SCALES**



Special stipulations for CSU and Timing Limitations, Forest Plan Standards and Guidelines and EPA requirements adequately mitigate impacts on individual species and genes (Fine Filter approach). In cases where communities occur in narrow corridors or small patches special stipulations and regulations may be used to protect specific plant community types. They effectively protect a small number of wildlife species with identified nesting or breeding areas.

However, these stipulations and regulations do not address creation of conditions for maintenance of the integrity of whole ecological systems, thereby sustaining the ecological and evolutionary context in which organisms exist and carry out integrated, uninterrupted processes. They do not perpetuate the integrated ecosystems which have developed as isolated patches or on specialized substrates.

From a landscape and community (Coarse Filter) standpoint, ecosystem disruption from oil and gas exploration and development of small patches of the matrix (sagebrush -grassland); does not pose substantial threats to the biological diversity of these ecosystems.

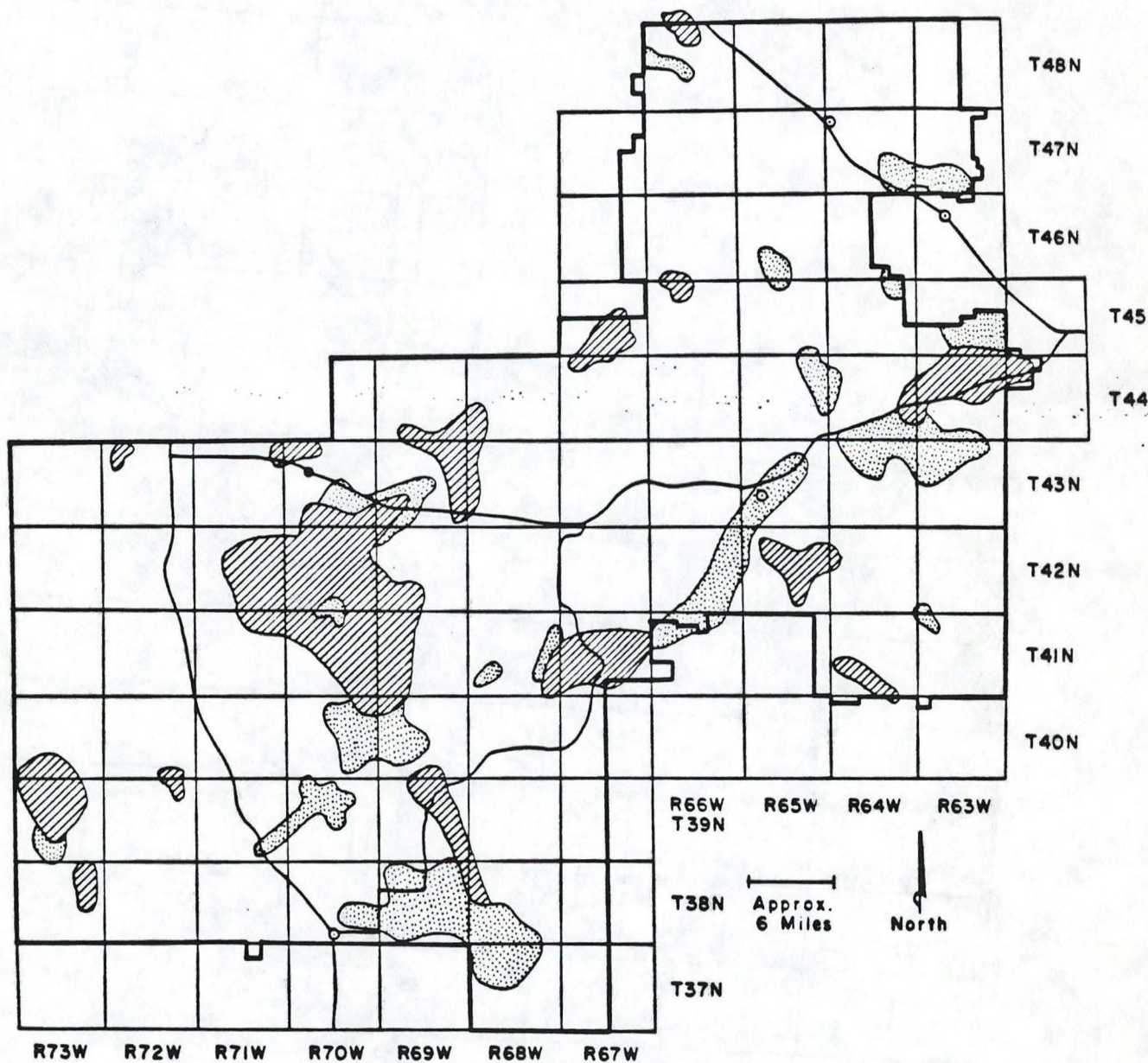
The sagebrush-grassland matrix is more dynamic than other shrublands or the woodlands. Patch transitions from grass-dominated communities to sagebrush steppe or vice versa, or recovery from denudation back to grassland or sagebrush steppe are common, and the mosaic in these areas





-  Upper Cretaceous rocks producing primarily oil
-  Lower Cretaceous rocks producing primarily oil

Source: Debruin, R. H. and C.S. Boyd. 1990. Oil and Gas Fields Map of the Powder River Basin, Wyoming Geological Survey of Wyoming Map MS-31

**FIGURE 5.1 OIL AND GAS FIELDS OF THE CHEYENNE RIVER BASIN**

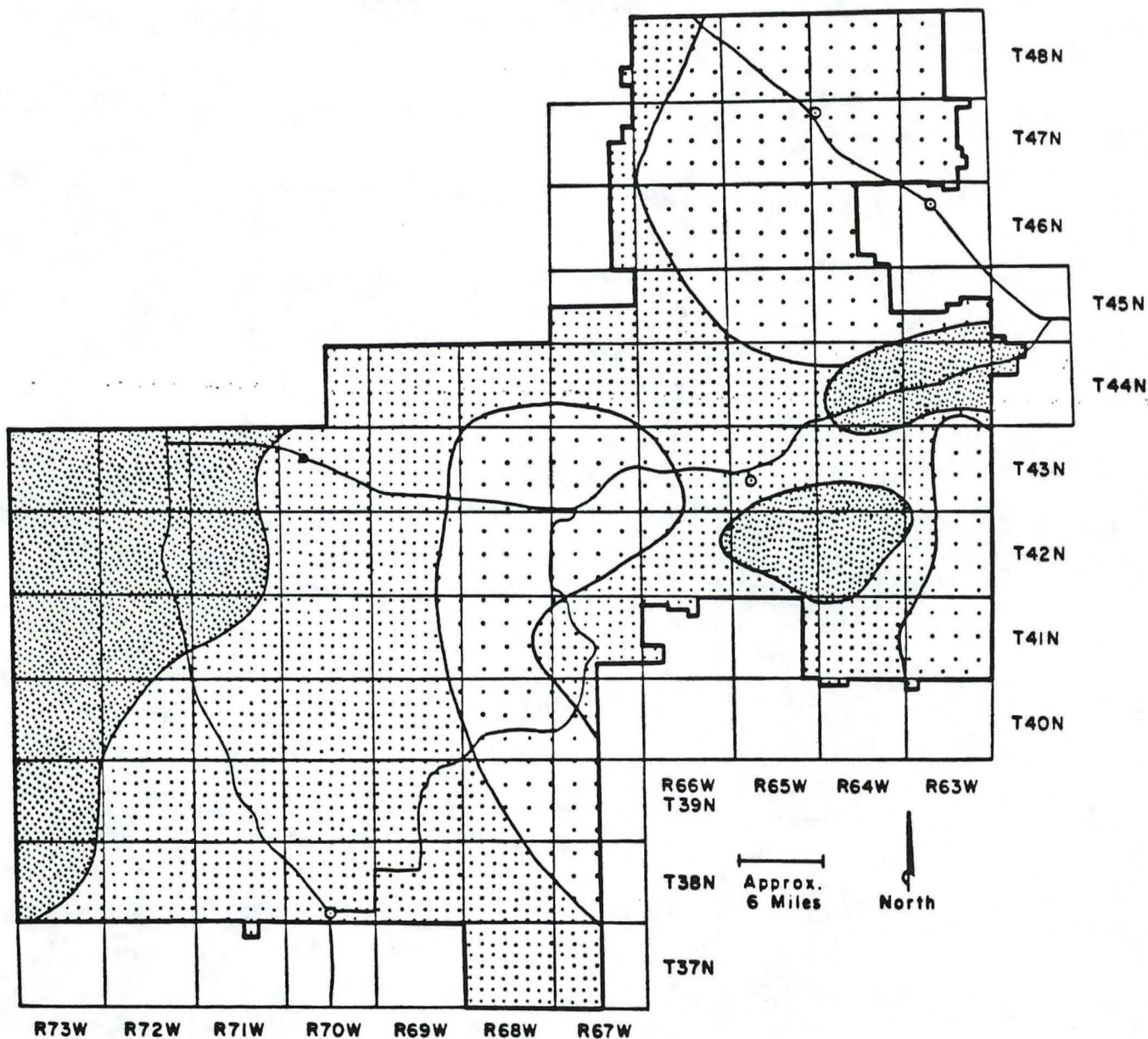


 Producing well areas

 Dry Hole areas (wells that are plugged which are either no longer in production or which were not producing wells)

Source: Douglas Ranger District Maps, 1992

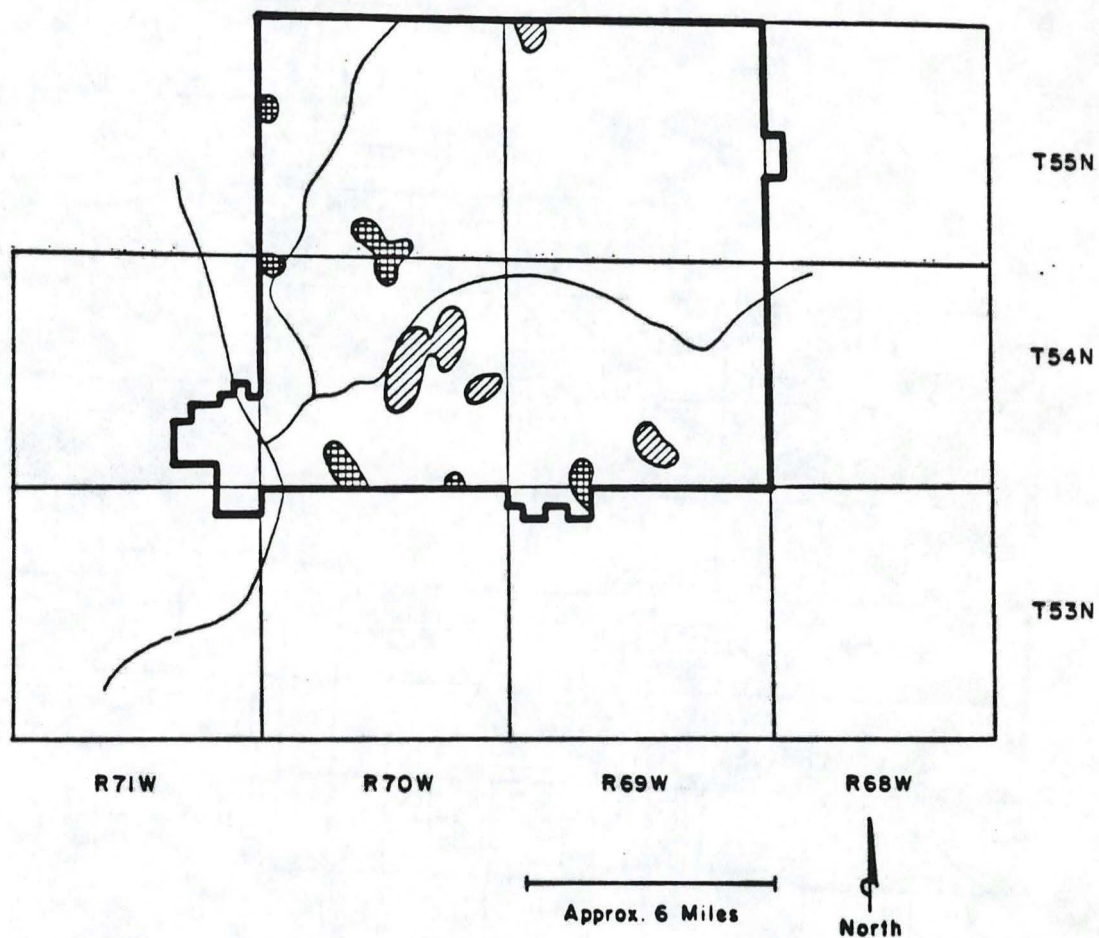
**FIGURE 5.2 PRODUCING WELL AND DRY HOLE AREAS**  
Cheyenne River Basin





-  High Development Potential
-  Medium Development Potential
-  Low Development Potential

Source: Oil and Gas Leasing on the Thunder Basin National Grassland  
Draft EIS June 4, 1992

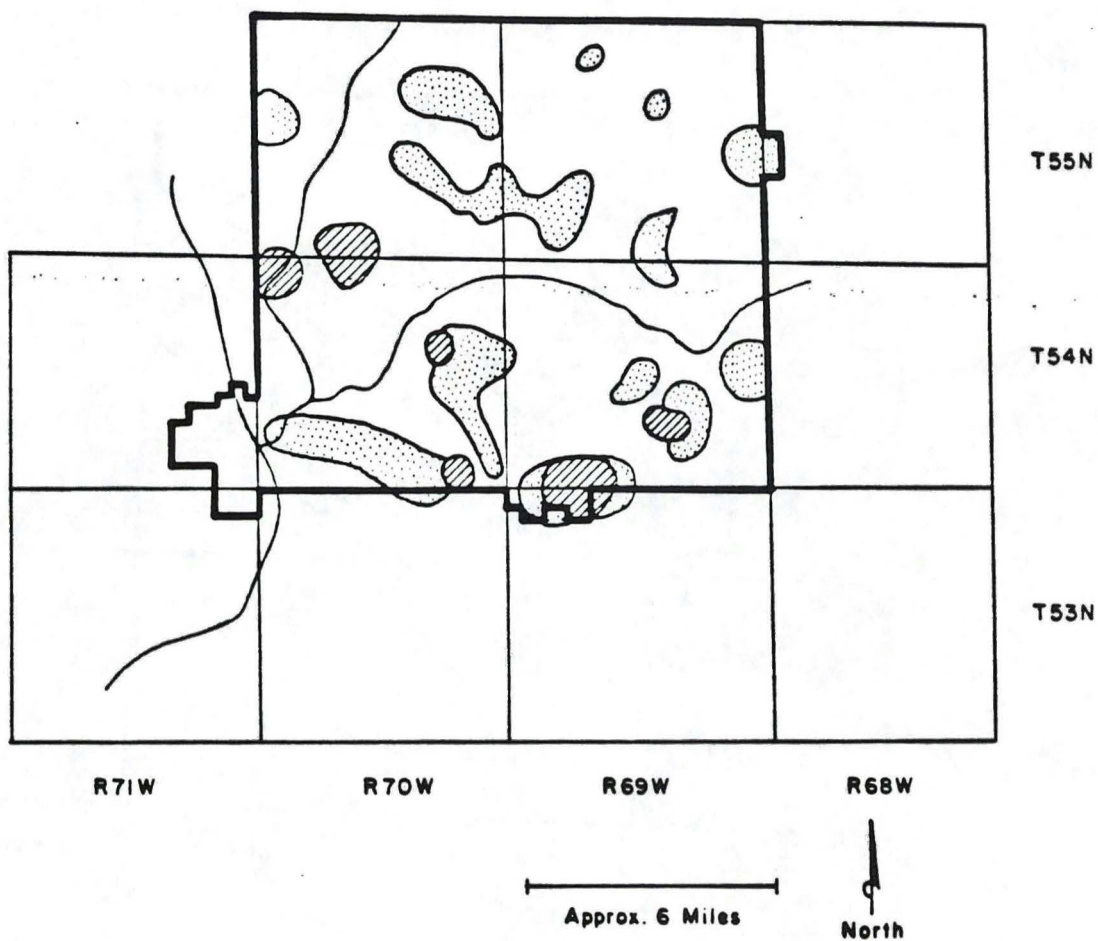
**FIGURE 5.3 REASONABLE FORESEEABLE DEVELOPMENT MODEL**  
Cheyenne River Basin




-  Lower Cretaceous rocks producing primarily oil
-  Permian-Pennsylvanian rocks producing primarily oil

Source: DeBruin, R.H. and C.S. Boyd. 1990. Oil and Gas Fields Map of the Powder River Basin, Wyoming. Geological Survey of Wyoming Map MS-31

**FIGURE 5.4 OIL AND GAS FIELDS OF THE SPRING CREEK UNIT**

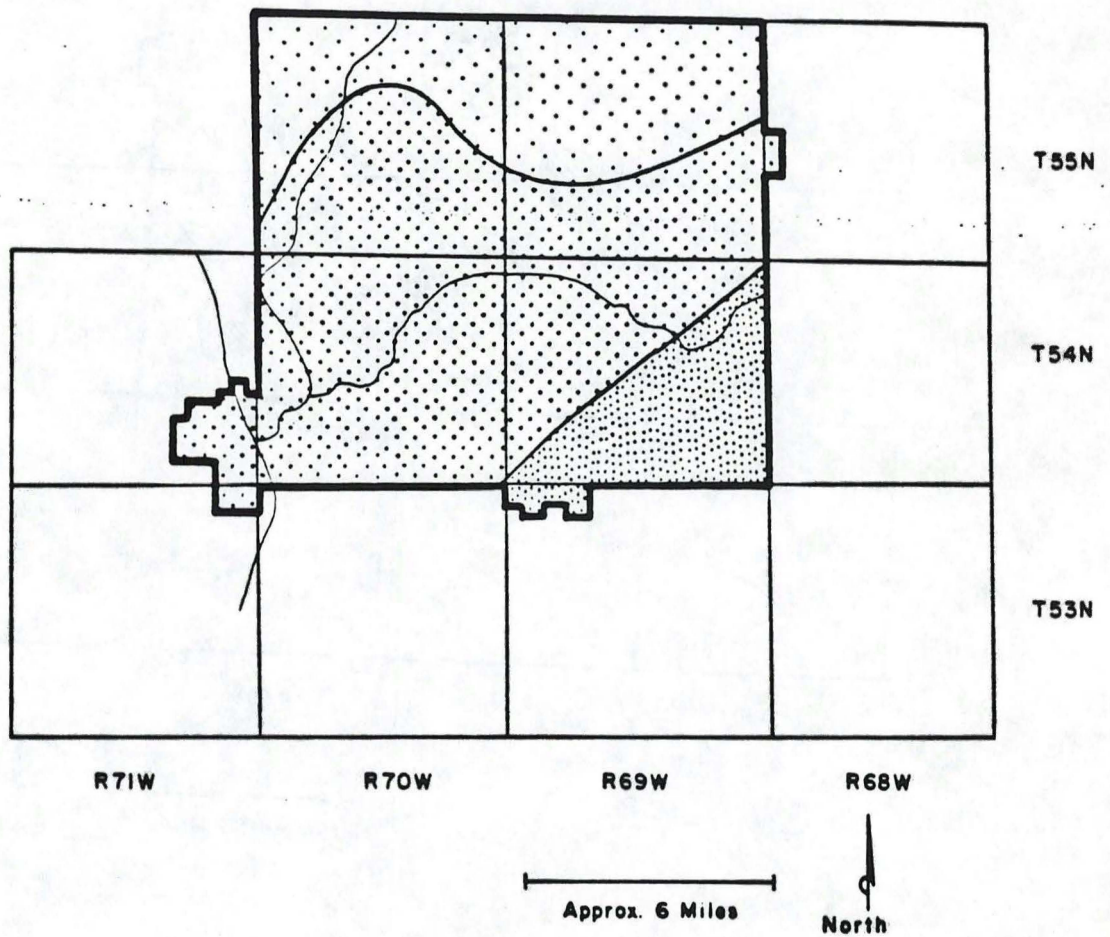





 Producing well areas

 Dry Hole areas (wells that are plugged which are either no longer in production or which were not producing wells)

Source: Douglas Ranger District Maps, 1992

**FIGURE 5.5 PRODUCING WELLS AND DRY HOLE AREAS OF THE SPRING CREEK UNIT**



-  Very High Development Potential
-  High Development Potential
-  Medium Development Potential

Source: Oil and Gas Leasing on the Thunder Basin National Grassland  
Draft EIS June 4, 1992

**FIGURE 5.6 REASONABLE FORSEEABLE DEVELOPMENT MODEL - Spring Creek Unit**

can accommodate this type of disturbance easily. Animals displaced by oil and gas activities have choices of nearby similar habitats.

The direct impacts to vegetation on the landscape and community scales are caused by the proliferation of roads and patches of disturbed areas due to the siting of drilling activities and production sites. Since both roads (which are corridors) and drill sites (which are patches) involve removal of the existing vegetation, there is potential for the spread of exotic species and noxious weeds.

Present exotic species and noxious weeds, which are aggressive invaders of disturbed land, include cheat grass, Russian thistle, kochia, leafy spurge and spotted knapweed. To date, none of these has posed a serious problem on existing sites. For information on control of undesirable plant species see Forest Wide Undesirable Plant Species and Noxious Weed Management Program (MBNF Environmental Analysis Report, 1992). (They have been controlled mechanically or by herbicides. Reclaimed sites are required to be seeded by native species. This results in small patches with initially lower biological diversity and areas which will undergo succession affecting horizontal diversity characteristics. The acreages affected are very small in relation to the area of the sagebrush shrub-steppe and sagebrush steppe matrix and grassland areas.

In contrast to the matrix, the impacts of oil and gas leasing on the biological diversity of patches of shrublands and woodlands within the matrix may be more disruptive to ecological composition, structure, processes and functions. These kinds of communities and landscapes are composed of long-lived woody perennial species and shrubs. Upland shrublands consisting of communities with Douglas rabbitbrush, birdsfoot sagebrush, fourwing saltbush, or skunkbrush sumac, and woodlands with ponderosa pine and juniper, are not as dynamic with regard to patch transitions as the sagebrush matrix, nor is succession as rapid. Many of these communities have not been shown to be replaced in kind after disturbance from road building or drill pads. If parts of these communities are removed, replacement by reclamation and succession is expected to be very slow and may not be achieved within a temporal framework appropriate for management (10 to 50 years).

Certain shrubland communities generally occur on shale or clay substrates, scoria, or soft sandstones. The flatter surfaces within these areas often supports birdsfoot sagebrush, which is a plant community highly specialized to its substrate, of patchy occurrence and uncommon. Areas of shrubland on the eroding Fort Union Formation, in particular the Lebo member in the Cheyenne River Basin, are more likely to be adversely impacted by oil and gas activities than the sagebrush and grassland types.

Woodland communities in the Rochelle Hills, Miller Hills, Cow Creek Buttes and Duck Creek areas form even smaller patches than the shrublands discussed above, and occur as isolated islands. The perennial woody plants which characterize these patches reproduce sporadically in response to mast seed years and climate constraints. Ponderosa pines and junipers in these ecosystems are at species

tolerance limits and may only produce replacement individuals in significant numbers a few times each century. The shrub and herbaceous communities which form a mosaic with these woodlands, create a tight system which provides specialized habitats for animals which have very limited choices for migration if they are displaced by human activities. The limited size of these patches makes them especially sensitive to disruption by roads, drill pads and subsequent human activity which may include increased hunting pressure, poaching or disturbance to restricted wildlife populations.

Woodlands or shrublands on steep slopes will not be affected by oil and gas leasing because soil conservation requirements will prevent roads and drill pads from occurring in those vegetation community types. Woodlands on flatter surfaces and which have dense canopies are likely to be more adversely affected by oil and gas leasing activities than more open woodland types where roads and drill pads may be located in grassy areas of the mosaic.

Birdsfoot sagebrush is the only major plant species which is expected to be directly impacted by oil and gas leasing. Birdsfoot sagebrush communities form small patches on flat or gently sloping surfaces in the badlands of the Fort Union Formation. These are also attractive areas for drill pad sites. Impacts to the populations of Candidate and disjunct plant species can be avoided by inventorying proposed site for these species. For some sites, specific mitigation measures may be possible at the APD stage.

In general, riparian areas, including playas, stream corridors and the riparian deciduous forest type, are not expected to be adversely impacted by oil and gas activities because regulations in the present Forest Plan and stipulations in Alternatives 2, 3, 4 and 6 provide adequate protection from road building and drill pad siting.

#### **IMPACTS TO TERRESTRIAL FAUNA BIOLOGICAL DIVERSITY**

Oil and gas leasing activities are not expected to have any direct significant impacts on terrestrial vertebrate species biological diversity, but indirect impacts are anticipated. Impacts on terrestrial invertebrates cannot be evaluated specifically because of lack of information, but no significant impacts are anticipated.

The indirect effects of oil and gas leasing include habitat loss, displacement of populations from road building and drill pad establishment, and increased mortality from road kills, breeding disturbance, harassment and increasing hunting pressure because of the proliferation of roads and ease of access by humans to previously unroaded or poorly accessible areas.

Trends in populations of Ecological Indicator Species are followed because they are expected to indicate trends in succession or condition of various vegetation types. Population changes for Indicator Species may possibly also represent population trends for other wildlife species with similar habitat requirements or life form characteristics.

Table 5.1 illustrates the trends in these indicator species for continental, regional, state, and TBNG populations. Those columns that are blank indicate species for which insufficient data was available to determine trends.

The following Candidate Species are sensitive to impacts by human activities (Finch, 1992);

Ferruginous hawk	Long-billed Curlew
Mountain Plover	Swift fox
	Preble's Meadow Jumping Mouse

The types of human impacts to these species are not directly associated with oil and gas development, however, such impacts as hunting/trapping and mortalities increase due to more numerous and improved roads because of oil and gas activities.

Other Candidate Species are listed as likely to be impacted by human activities by Finch (1992) because their habitats are limited or vulnerable to disturbance:

Black Tern	Loggerhead Shrike
Mountain Plover	White-faced Ibis
Ferruginous Hawk	Fringed Myotis
	Preble's Meadow Jumping Mouse.

These habitat impacts are related mainly to agriculture/grazing practices or pest control because they affect large areas. Oil and gas development is expected to have less impact on these species since ground disturbances associated with oil and gas development tends to be limited in size to small patches (approximately two acres with associated roads)(see Reasonable Foreseeable Development section of EIS).

With existing proposed stipulations designed to prevent unacceptable impacts to wildlife populations, oil and gas leasing is not expected to have a unacceptable negative impact on wildlife migrations or on corridor use.

Oil and gas leasing and the resulting potential for road development and human intrusion into previously unroaded areas may increase the mortality of many species. Game animal harvest may increase due to the increased accessibility due to new roads and increased human presence. Mortalities are expected to increase for many species due to collisions with vehicles associated with the increased activity.

Oil and gas leasing is not expected to have an effect on the genetic diversity of wildlife populations on the TBNG. Isolated populations already exist, caused by the scattered nature of natural habitat islands. The Black Hills Red-bellied snake is believed to be one such population (Finch, 1992; Behler and King, 1979), and the fringed myotis is also considered to be an isolated population on the TBNG. Based on the Reasonable Foreseeable Development scenerio, these populations should not be adversely affected by oil and gas leasing.

TABLE 5.1

## ECOLOGICAL INDICATOR SPECIES STATUS

Species	Continental (%)	Regional (%)	State (%)	TBNG (%)
prairie vole	-	-	inc	-
black tailed prairie dog	-	-	-	inc
sage grouse	-	-	-	decr
yellow breasted chat	decr (-0.8)	inc (16.3)	decr (-10.7)	-
golden eagle	decr (-0.7)	decr (12.8)	decr (-8.8)	decr
Brewer's sparrow	decr (-3.5)	decr (-10.6)	decr (-9.4)	-
willow flycatcher	-	-	-	-
house wren	inc (1.4)	inc (0.5)	decr (-6.8)	-
ferruginous hawk	inc (0.5)	inc (3.2)	decr (-4.0)	decr
red crossbill	inc (1.1)	inc (22.3)	decr (-2.7)	-
mountain plover	-	decr	decr (-2.2)	decr
upland sandpiper	inc (3.7)	decr (-0.2)	inc (0.5)	-
longbilled curlew	decr (-0.7)	decr (-10.4)	-	-
red-headed woodpecker	decr (-1.2)	decr (-3.0)	decr (-1.8) (1966-1989)	-

Compiled from: National Breeding Bird Surveys; State of Wyoming Game and Fish Department Surveys for Sage Grouse (WY G&F, 1992 Personal communication); Douglas Ranger District Wildlife construct surveys for Golden eagle and ferruginous hawk (1981-1992); Antelope Coal Mine for mountain plover.

inc = increasing

decr = decreasing

- = insufficient data to evaluate population trends

X = no data available

All of the analysis regarding wildlife is done at the Fine Filter (species and genes) level. Mitigation in the Alternatives (CSU, Timing Limitations) is also at the Fine Filter Level.

#### IMPACTS TO AQUATIC BIOLOGICAL DIVERSITY

A discussion of the potential impacts of oil and gas activities on aquatic community and species diversity is presented below. Aquatic habitat types and the biological communities associated with these habitat types may reflect degradation differently depending upon the current condition of the habitat type and current water quality.

Fish and macroinvertebrate taxa have been classified as tolerant or intolerant according to their presence or absence in various aquatic habitats. Clean water taxa (those which have an assigned tolerance of 4 [Speas, 1992]) or less are given twice the weight as tolerant organisms in the formula:

$$2(n \text{ Intolerant}) + (n \text{ Tolerant}) = \text{Biotic Index}$$

where "n" is the number of taxa in that class (Beck, 1955). Biotic Index Values less than 10 are considered to indicate a polluted stream. Table 5.2 is a general model of habitat type ranges of sensitivity to change in environmental quality.

Tolerance to environmental change is modeled by the presence or absence of invertebrate taxa that are generally believed to be pollution-sensitive such as Ephemeroptera (mayflies), Plecoptera (stoneflies), helgrammites and Trichoptera (caddis flies) or the excess dominance of any particular taxon, especially pollution tolerant forms such as Chironomidae (midges) and Oligochaeta (worms). Other indicators of ecosystem health include the composition of algal and fish populations. For example, an overabundance of filamentous algae, green, or blue-green algae is indicative of a nutrient rich environment and usually is indicative of lessened ecosystem health.

Fish species richness and composition provide information on watershed condition because various fish occupy specific positions in the aquatic food web. The array of fishes generally includes species that represent a variety of feeding levels (omnivores, herbivores, insectivores, planktivores, piscivores).

Macroinvertebrate and fish populations as well as water quality, channel form and flow regimes (Wesche and McTernan (1977) were all used to develop the following Pollution Tolerance Models. Because the data presented in these models is an aggregate of data from various sources it is not strictly quantitative. Pollution tolerance levels for macroinvertebrates known to exist in Wyoming have been developed by Plafkin et al (1989), Klemm et al (1990) and from King (1991). Tables 5.3 - 5.8 provide pollution tolerance levels for fish and macroinvertebrates collected on the Thunder Basin National Grassland.

**TABLE 5.2 BIOTIC INDICES FOR STREAM POOL HABITAT TYPES.** Diversity Index, condition and tolerance of biological communities to environmental change.

STREAM HABITAT TYPE <sup>1</sup>	SHANNON-WEAVER INDEX RANGE	STREAM CONDITION	BIOTIC INDEX <sup>2</sup>	TOLERANCE
Permanent, clear-water pool on ephemeral or intermittent stream  -Little Thunder Creek -portions of Antelope Creek	1.5-2.0	low-good	35	moderate
Ephemeral pool on ephemeral stream  -School Creek	0.5-1.5	low-fair	22	high
Permanent, turbid water pool on intermittent stream  -portions of Antelope Creek -Cheyenne River	0.5-1.0	low-fair	11	high
Turbid water pool in severely incised reach of perennial stream  -portions of Little Powder -Beaver Creek	1.0-1.5	fair	18	moderate
Turbid water pool on perennial stream; less severely incised with lateral erosion  -portions of Little Powder	2.0-2.5	low-good	22	moderate

<sup>1</sup> representative examples; a comprehensive listing of habitat types for all drainages is not available.

<sup>2</sup> Biotic index from Beck (1955).

**TABLE 5.3 POLLUTION TOLERANCE MODEL FOR FISH AND MACROINVERTEBRATES IN PERMANENT, CLEAR-WATER POOL HABITAT TYPES ON THUNDER BASIN NATIONAL GRASSLAND**

STREAM HABITAT TYPE	FISH TAXA	POLLUTION TOLERANCE	MACROINVERTEBRATE TAXA	POLLUTION TOLERANCE
Permanent clear water pools on ephemeral or intermittent stream	Fathead minnow	tolerant	Two-winged flies	
	White sucker	tolerant	<u>Pentaneura</u> sp.	
	Black bullhead	intermediate	<u>Palpomyia</u> sp.	6
	Green sunfish	tolerant	<u>Probezzia</u> sp.	
	Bluegill	tolerant	<u>Dasyhella</u> sp.	
	Largemouth bass	tolerant	<u>Chrysops</u> sp.	6
	Plains minnow		<u>Tabanus</u> sp.	
	Sand shiner	intermediate	<u>Dixa</u> sp.	
			Beetles	
			<u>Heliphus</u> sp.	5
			<u>Berosus</u> sp.	
			<u>Hydroporus</u> sp.	5
			<u>Dubiraphia</u> sp.	6
			<u>Donacia</u> sp.	
			Mayflies	
			<u>Caenis</u> sp.	7
			Caddisflies	
			<u>Polycentropus</u> sp.	
			<u>Phryganea</u> sp.	4
			<u>Limnephilus</u> sp.	3
			Damselfly and dragonflies	
			<u>Ischnura</u> sp.	9
			<u>Anomalagrion</u> sp.	
			<u>Cordulia</u> sp.	4

STREAM HABITAT TYPE	FISH TAXA	POLLUTION TOLERANCE	MACROINVERTEBRATE TAXA	POLLUTION TOLERANCE
			Water bugs	
			Corixidae	8
			Shrimp	
			<u>Hyallela azteca</u>	8
			Water mites	
			<u>Neumania</u> sp.	5
			<u>Megapus</u> sp.	5
			<u>Leberta</u> sp.	5
			<u>Limnesia</u> sp.	5
			Worms	
			Tubificidae	6-10
			Hirudinea	10
			Snails	
			<u>Physa</u> sp.	8
			<u>Gyraulus</u> sp.	6
			<u>Lymnaea</u> sp.	6
			<u>Ferrissia</u> sp.	6
			Clams	
			<u>Pisidium</u> sp.	8

Pollution tolerance levels were obtained from Plafkin et al. (1989), Klemm et al. (1990) and from King (1991).

**TABLE 5.4 POLLUTION TOLERANCE MODEL FOR FISH AND MACROINVERTEBRATES COLLECTED FROM EPHEMERAL STREAMS WITH EPHEMERAL POOLS ON THUNDER BASIN NATIONAL GRASSLAND**

STREAM HABITAT TYPE	FISH TAXA	POLLUTION TOLERANCE	MACROINVERTEBRATE TAXA	POLLUTION TOLERANCE
Ephemeral pool on ephemeral stream	Black bullhead	intermediate	Widge	
	Fathead minnow	tolerant	<u>Chironomus</u> sp.	10
	White sucker	tolerant	<u>Pentaneura</u> sp.	
			<u>Palpomyia</u> sp.	6
			<u>Dasyhelea</u> sp.	6
			<u>Chrysops</u> sp.	6
			<u>Nematelus</u> sp.	8
			Beetles	
			<u>Dubiraphia</u> sp.	6
			<u>Haliphus</u> sp.	5
			<u>Celine</u> sp.	6
			<u>Coptotomus</u> sp.	6
			<u>Berosus</u> sp.	5
			Mayflies	
			<u>Caenis</u> sp.	7
			Caddisflies	
			<u>Limnephilus</u> sp.	3
			Water bugs	
			<u>Dipsocoridae</u>	
			Damselfly and dragonflies	
			<u>Lestes</u> sp.	
			<u>Ischnura</u> sp.	9
			Worms	
			Tubificidae	6-10
			Snails	
			<u>Physa</u> sp.	8
			<u>Gyraulus</u> sp.	6

STREAM HABITAT TYPE	FISH TAXA	POLLUTION TOLERANCE	MACROINVERTEBRATE TAXA	POLLUTION TOLERANCE
			<u>Lymnaea</u> sp.	6
			Clams	
			<u>Pisidium</u> sp.	8

Pollution tolerance levels are from Plafkin et al. (1989), Klemm et al. (1990) and from King (1991).

**TABLE 5.5 POLLUTION TOLERANCE MODEL FOR FISH AND MACROINVERTEBRATES IN PERMANENT, TURBID-WATER POOL HABITATS ON INTERMITTENT STREAMS ON THUNDER BASIN NATIONAL GRASSLAND, WYOMING**

STREAM HABITAT TYPE	FISH TAXA	POLLUTION TOLERANCE	MACROINVERTEBRATES	POLLUTION TOLERANCE
Permanent turbid water pool on intermittent stream	Sand shiner	intermediate	Nidge	
	Fathead minnow	tolerant	<u>Pentaneura</u> sp.	
	Flathead chub		<u>Chironomus</u> sp.	10
	Plains killifish		<u>Palpomyia</u> sp.	6
	black bullhead	intermediate	Mayflies	
			<u>Caenis</u> sp.	7
			Damsel and dragonflies	
			Coenagrionidae	9
			Water bugs	
			Dipsocoridae	
			Shrimp	
			<u>Hyallela azteca</u>	8
			Worms	
			Tubificidae	6-10
			Snails	
			<u>Physa</u> sp.	8
			<u>Lymnaea</u> sp.	6
			Clams	
			<u>Pisidium</u> sp.	8

Pollution tolerance levels are from Plafkin et al. (1989), Klemm et al. (1990) and King (1991).



**TABLE 5.6 POLLUTION TOLERANCE MODEL FOR FISH AND MACROINVERTEBRATES IN TURBID-WATER POOL HABITATS IN SEVERELY INCISED REACHES OF PERENNIAL STREAMS ON THUNDER BASIN NATIONAL GRASSLAND**

STREAM HABITAT TYPE	FISH TAXA	POLLUTION TOLERANCE	MACROINVERTEBRATE TAXA	POLLUTION TOLERANCE
Turbid water pool on severely incised perennial stream	Black bullhead	intermediate	Midge	
	Green sunfish	tolerant	<u>Pentaneura</u> sp.	
	River carp- sucker		<u>Chironomus</u> sp.	10
	Northern redbhorse		<u>Palpomyia</u> sp.	6
	White sucker	tolerant	Beetles	
	Plains minnow		<u>Dubiraphia</u> sp.	6
	Sand shiner	intermediate	Caddisflies	
	Carp	tolerant	<u>Polycentropus</u> sp.	6
	Flathead chub		Mayflies	
	Fathead minnow	tolerant	<u>Caenis</u> sp.	7
	Longnose dace	intermediate	Damsel and dragonflies	
			Coenagrionidae	9
			Water bugs	
			Corixidae	8
			Belostomatidae	8
			Wellgrammites	
			<u>Sialis fuliginosa</u>	4
			Shrimp	
			<u>Hyallela azteca</u>	8
			Water mites	
			<u>Neumania</u> sp.	5
			Worms	
			Tubificidae	6-10
			Snails	
			<u>Physa</u> sp.	8
			<u>Lymnaea</u> sp.	6

STREAM HABITAT TYPE	FISH TAXA	POLLUTION TOLERANCE	MACROINVERTEBRATE TAXA	POLLUTION TOLERANCE
			<u>Gryaulus</u> sp.	6
			Clams	
			<u>Pisidium</u> sp.	8

Pollution tolerance levels are from Plafkin et al. (1989), Klemm et al. (1990) and King (1991).

**TABLE 5.7 POLLUTION TOLERANCE MODEL FOR FISH AND MACROINVERTEBRATE FAUNA IN TURBID-WATER POOL HABITATS OF PERENNIAL STREAMS that are less severely incised and have lateral erosion of the channel. Thunder Basin National Grassland.**

STREAM HABITAT TYPE	FISH TAXA	POLLUTION TOLERANCE	MACROINVERTEBRATE TAXA	POLLUTION TOLERANCE
Turbid water pool on less severely incised perennial stream	Black bullhead	intermediate	<b>Widges</b>	
	Green sunfish	tolerant	<u>Chironomus</u> sp.	10
	White sucker	tolerant	<u>Pentaneura</u> sp.	
	River carpsucker		<u>Palpomyia</u> sp.	6
	Northern redhorse		<u>Chrysops</u> sp.	8
	White sucker	tolerant	<b>Beetles</b>	
	Plains minnow		<u>Dubiraphia</u> sp.	6
	Sand shiner	intermediate	<u>Heliphus</u> sp.	5
	Carp	tolerant	<b>Mayflies</b>	
	Flathead chub		<u>Caenis</u> sp.	7
	Fathead minnow	tolerant	<b>Water bugs</b>	
	Longnose dace	intermediate	Corixidae	8
	Stonecat	intolerant	Dipsocoridae	
	gold eye	intolerant	<b>Caddisflies</b>	
			<u>Ptilostomis</u> sp.	5
			<b>Damself and dragonflies</b>	
			<u>Ischnura</u> sp.	9
			<u>Progomphus</u> sp.	4
			<u>Macromia</u> sp.	9
			<b>Water mites</b>	
			<u>Limnochares</u> sp.	5
			<u>Neumania</u> sp.	5
			<b>Shrimp</b>	
			<u>Hyallela azteca</u>	8
			<b>Worms</b>	
			Tubificidae	6-10



**TABLE 5.8 FISH, MACROINVERTEBRATE AND ZOOPLANKTON FAUNA COLLECTED FROM RESERVOIRS AND STOCKPONDS ON THUNDER BASIN NATIONAL GRASSLAND POLLUTION TOLERANCE MODEL IS ONLY FOR FISH**

FISH TAXA	POLLUTION TOLERANCE	MACROINVERTEBRATE TAXA*	ZOOPLANKTON TAXA
Brown trout	intermediate	Ephemeroptera (mayflies)	Copepods
Rainbow trout	intermediate	Odonata (Damsel and dragonflies)	<u>Acanthocyclops vernalis</u>
Brook trout	intermediate	Diptera (Two-winged flies)	<u>Diacyclops bicuspidatus thomasi</u>
Channel catfish	intermediate	Amphipoda (Shrimp)	<u>Diaptomus clavipes</u>
Black bullhead	intermediate	Pulmonata (Snails)	<u>Diaptomus sicilis</u>
Largemouth bass	intermediate	Trichoptera (Caddisflies)	<u>Diaptomus siciloides</u>
Smallmouth bass	intermediate		<u>Eucyclops agilis</u>
Green sunfish	tolerant		<u>Eucyclops speratus</u>
Bluegill	intermediate		<u>Macrocyclus albidus</u>
Black crappie	intermediate		Cladocera
Common carp	tolerant		<u>Alona rectangula</u>
White sucker	tolerant		<u>Alona rustica</u>
Yellow perch	intermediate		<u>Bosmina longirostris</u>
Rock bass	intermediate		<u>Ceriodaphnia quadrangula</u>
			<u>Chydorus sphaericus</u>
			<u>Daphnia pulex</u>
			<u>Daphnia rosea</u>
			<u>Diaphanosoma brachyurum</u>
			<u>Leydigia laticornis</u>
			<u>Moina micrura</u>
			<u>Moina macropoda</u>
			<u>Pleuroxus denticulatus</u>
			<u>Simocephalus vetulus</u>
			Rotifera
			<u>Anuraeopsis sp.</u>
			<u>Ascomorpha sp.</u>
			<u>Asplanchna spp.</u>
			<u>Brachionus spp.</u>

FISH TAXA	POLLUTION TOLERANCE	MACROINVERTEBRATE TAXA*	ZOOPLANKTON TAXA
			<u>Cephalodella</u> spp.
			<u>Colurella</u> spp.
			<u>Conochilus</u> sp.
			<u>Epiphanes</u> sp.
			<u>Euchlanis</u> spp.
			<u>Filinia</u> sp.
			<u>Hexarthra</u> sp.
			<u>Keratella</u> spp.
			<u>Lecane</u> spp.
			<u>Lepadella</u> spp.
			<u>Lophocharis</u> sp.
			<u>Monostyla</u> spp.
			<u>Platyias</u> sp.
			<u>Polyarthra</u> spp.
			<u>Synchaeta</u> sp.
			<u>Testudinella</u> sp.
			<u>Trichocerca</u> spp.

\* Macroinvertebrate identification has only been conducted down to the Order level of taxonomic classification. Data from Rahel and Keleher (1992) and King (1990) and Douglas Ranger District files. Pollution tolerance levels for fish are from Plafkin et al. (1989).

## **Mechanisms and Probability of impact**

Human induced alterations, including oil and gas activities, could impact the ecological health of aquatic systems on Thunder Basin. The sensitivity of various aquatic habitats presented in Table 5.2 provides a guide to which aquatic habitats are most susceptible to stress from environmental disturbance resulting from introduced point and non-point pollution sources. If oil and gas activities are determined to pose a threat to water quality, specific mitigation measures for aquatic communities may be required under Section 6 of the Standard Lease Terms. These threats may include impacts to flow regimes or physical, chemical and biological components of the water resource. Mechanisms and probability of impact are discussed below:

### **Streamflow**

Alteration of streamflow regime could alter the types and quantity of aquatic fauna expected in stream habitats currently existing on the Grasslands. For example, if streamflows in perennial streams such as the Little Powder River became intermittent then fish and invertebrates that require habitats associated with perennial streams would decline or be eliminated. Communities inhabiting ephemeral streams are adapted to life in lentic (standing water) habitats, such as pools. The body structure, feeding habits, and respiratory system of invertebrates adapted to lentic environments are different than invertebrates adapted to life in a lotic (flowing water) habitat. Invertebrates adapted to lentic habitats can survive in pools of perennial or intermittent streams, but invertebrates adapted to lotic environments have a large mortality rate in lentic habitats.

The amount of additional disturbed area in Alternatives 1,2,3,4, and 6 would be 20 to 50 acres annually or a total of 300 to 750 acres for the 15-year planning period. In 15 years only 0.05 to 0.12 of the federally owned surface on TBNG would be disturbed from oil and gas activities. Ziemer (1987) found that in areas with precipitation less than 15 inches annually, little (not measurable) effect on peak streamflows occurs. The average annual precipitation for Thunder Basin is approximately 12 inches. There is also no evidence that the removal of grass and shrubs common to TBNG will have any effect on the amounts and timing of waterflow. No direct, or indirect effects to water quantity and flow characteristics is expected from surface disturbance resulting from oil and gas activities.

### **Changes in Energy Sources**

Energy becomes available to aquatic systems from two main sources: photosynthesis by aquatic plants in the stream or lake itself (autochthonous) and decomposition of organic matter imported from outside the stream (allochthonous). These energy sources have a major influence on the structure and function of stream ecosystems. Energy sources can be affected in the following manner.

## Riparian Vegetation Alteration

Riparian vegetation may be affected through the construction of roads. Such instances would be rare since every attempt will be made to avoid riparian, wetland and riparian areas as specified by the Controlled Surface Use stipulation for these areas. If riparian vegetation is removed then amount of litterfall from streamside vegetation would be reduced. Macroinvertebrates dependent upon this energy source for food (e.g. shredders) could potentially be reduced. These impacts would be localized and very minimal.

Changes in autochthonous energy sources could occur if the removal of riparian vegetation resulted in an increase in stream temperatures. Under such circumstances, increases in algal growth, especially green and blue-green algae, could occur. Those macroinvertebrates and fish species that are more tolerant of such changes could dominate the community. On Thunder Basin National Grassland streams, temperatures during the summer months commonly approach 30 degrees Celsius (See Appendix I-3 FEIS). This combined with organic enriched waters result in the vast majority of algae communities existing on the Grasslands to be dominated by green, blue-green, and euglenoid algae. Further changes in stream temperature that could result in a significant change in the type and quantity of algae or vascular plants is not likely.

## Water Quality

Mechanisms of impact to water quality have been discussed under the Water Quality, Environmental Consequences section of the EIS. Streamflows on Thunder Basin fluctuate widely in water quality depending upon discharge and time of the year (see Appendix G - Oil and Gas Leasing FEIS for TBNG). Most streams are highly buffered, moderately alkaline and can contain high concentrations of calcium, magnesium, sodium and sulfate. Fish and invertebrate communities have adapted to these highly variable water quality conditions. Most macroinvertebrate and fish species occurring within the Thunder Basin National Grassland are considered tolerant to moderate to high concentrations of heavy metals and organic wastes (Plafkin et al., 1989 and Klemm et al., 1990). Through proper mitigation and strict adherence to the CSU stipulation for riparian, floodplains and wetlands, neither water quality nor stream flow are expected to be adversely impacted from oil and gas leasing.

## Habitat Quality

Stream habitat conditions range from low-fair to low-good based on visual observations of habitat conditions, the range of macroinvertebrate diversity values and the existence of intolerant fish and macroinvertebrate taxa (Tables 5.2 - 5.8). The mechanisms of impact to aquatic habitat quality are discussed in the Water Quality, Environmental Consequences Section of the DEIS. Generally, streams that have clear water will be the most susceptible to impact from ground disturbing activities. If roads, oil pads, etc. were

constructed adjacent to these habitats increased sedimentation could reduce taxa more sensitive to sediment (e.g. mayflies). Aquatic biota in streams that carry high quantities of suspended sediment (e.g. Cheyenne River) would be less affected since these communities have adapted to such conditions.

Produced waters from oil production facilities can exhibit both acute and chronic toxicity to macroinvertebrate, zooplankton and certain fish species (e.g. fathead minnows). Surface discharge from produced waters from oil facilities in Wyoming are regulated through the National Pollution Discharge Elimination System (NPDES) under the auspices of the U.S. EPA and Wyoming Department of Environmental Quality (WDEQ). Studies have been conducted on reservoir aquatic fauna receiving such effluent within the affected watersheds (King, 1990). These studies indicate no change in the abundance or type of aquatic fauna in reservoirs and ponds receiving produced water as compared to those that do not. The type of aquatic communities are more associated with the physical lake environment rather than effects of production water induced changes in water quality.

With close adherence to the CSU stipulation for riparian, wetlands, and floodplains and continued enforcement by WDEQ of the NPDES permitting system little change in water quality that would alter aquatic biota assemblages is expected.

#### Biotic Interactions

Management activities, including those associated with oil and gas, could alter aquatic fauna species composition and thus biotic interactions through the following mechanisms:

1. increased frequency of diseased fish due to reduced water or changes in physical stream habitat.
2. increased primary production from algal blooms resulting from increased organic enrichment (e.g. livestock, increased sewage from increased human inhabitation of the area). Under such circumstances, invertebrate functional groups could change (increased numbers of scrapers which utilize algae for food and decreased numbers of shredders who rely primarily on leaves and twigs for food).
3. shifts in species composition and relative abundances due to reduced water quality or changes in physical stream habitat. Fish communities would be altered by increased numbers of omnivores and a decrease in carnivores, particularly fish eaters. Those macroinvertebrates more tolerant of reduced water quality (e.g. chironomids) would increase and pollution sensitive species (e.g. mayflies, caddisflies and hellgrammites) would decrease or be eliminated.

Management activities, including those associated with oil and gas are not expected to significantly affect water quality or physical stream

habitat. No significant changes in species composition or relative abundance of organisms is expected to occur.

#### **SUMMARY OF ENVIRONMENTAL CONSEQUENCES**

The mitigation measures contained in Forest Plan Standards and Guidelines and standard lease terms address mitigation for biological diversity concerns mainly at the species level for specific species, or at the community levels for some communities, in particular, aquatic communities. Special stipulations for controlled surface use and timing limitations are applicable mainly to species biological diversity concerns. These special stipulations have some limited applicability to community level concerns for both plant and animal biological diversity components for both terrestrial and aquatic systems.

Adverse impacts at the Coarse Filter Level (landscape and community) visibly affect groups of terrestrial plant communities which collectively form patches of landscape which are different from the sagebrush-steppe matrix of the Thunder Basin National Grassland. These adverse effects include fragmentation of these landscapes, degradation of existing ecological integrity and unknown effects on other dimensions of ecosystems such as soils, energy and nutrient flows and organisms interactions. As a result of changes in composition, structure, processes and functions of the vegetation landscape components, animal populations in these patches may be directly or indirectly adversely affected.

Adverse impacts at the Fine Filter Level for some terrestrial vertebrates (threatened and endangered species, some indicator species, other selected species) and aquatic organisms, can be mitigated adequately using Forest Plan Standards and Guidelines, standard and special lease stipulations (CSU and Timing Limitations) and Threatened and Endangered Species Laws. Since few data exist on many species, including some National Forest indicator species, specific adverse effects cannot be predicted for most species. Populations of animal species which can utilize early seral stages or which are tolerant of noise and human activity may increase.

Adverse impacts on aquatic landscapes and communities and their associated ecosystem functions can be adequately mitigated through Forest Plan Standards and Guidelines, State Water Quality regulations, standard lease terms and special stipulations.

Alternatives 1 and 5 provide the least mitigation for direct and indirect impacts of oil and gas leasing on biological diversity because only the provisions of standard lease terms, Forest Plan Standards and guidelines and provisions of laws such as the Clean Water Act, the Endangered Species Act and State Laws would be applied. Alternative 2 provides more mitigation than Alternatives 1 or 5 because of the application of special stipulations for Controlled Surface Use, Timing Limitations and No Surface Occupancy for specific species or restricted, specific sites. All three of these alternatives contain

mitigation measures focused mainly at the species (Fine-filter) level of biological diversity.

Alternatives 3 and 4, because of the larger patches to which Controlled Surface Use or Timing Limitations would be applied, provide the best mitigation for impacts to biological diversity. Alternative 4 was the preferred Alternative presented in the DEIS, for perpetuation of biological diversity. The application of No Surface Occupancy to landscape patches, the size of which permits inclusion of whole or nearly whole ecosystem units (consisting of interacting communities of organisms which differ in composition, structure, processes and functions from the surrounding landscape matrix), promotes the perpetuation of biological diversity better than the Alternatives which have mitigation measures applicable only to specific species or small areas. We recommend modification of boundaries and addition of another area to those proposed in Alternative 4, in order to adequately mitigate impacts on biological diversity.

1. The first part of the paper is devoted to the study of the properties of the function  $f(x)$  defined by the equation

## CHAPTER VI

### CUMULATIVE EFFECTS

Cumulative effects on biological diversity, from human activities, result from impacts through time from grazing of domestic animals, hunting, animal damage management, fire suppression, water diversion and water development, coal, uranium and bentonite mining, use of herbicides, roads, off-road vehicles, and oil and gas leasing. These effects cause changes in the natural order on many different scales.

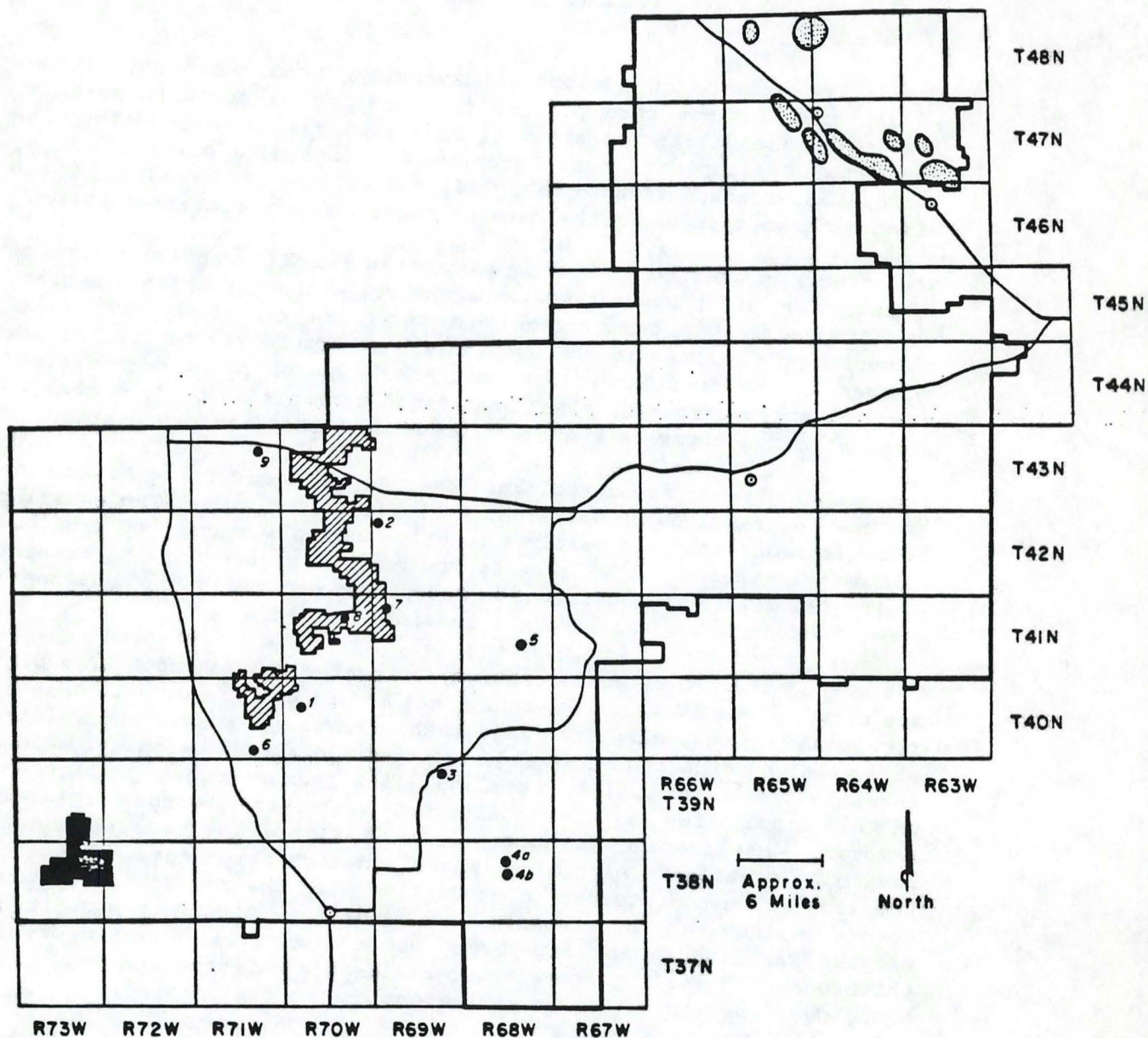
The effects range from changes in gene pools and differential selection of animal or plant species to landscape scale changes which are based on changes in the composition and structure of plant and animal communities. Changes in composition and structure may be from direct changes in the condition, seral stage or type of plant communities; from the interactions of plant and animal communities or from changes in aquatic and riparian systems discussed in the previous chapter.

Cumulative effects are unavoidable because of co-occurring activities and the interactions of different activities over time. The existing biological diversity is partly a function of the summation of previous cumulative effects. The issue is how much alteration of the present biological diversity conditions is acceptable because of the additional effects of continued oil and gas leasing.

The areas affected by coal, uranium, bentonite mining and scoria pits are shown in Figure 6.1. The coal mines affect shrublands with Douglas rabbitbrush, yucca, birdsfoot sagebrush, skunkbrush sumac; communities on scoria and riparian areas and dissected sideslopes especially along Antelope Creek, Porcupine Creek and Black Thunder Creek. Plant and animal communities in the coal-mined areas are being completely removed. Replacement is generally with simpler systems which are basically grasslands with minor shrub and forb components. Although the land is being returned to productive use, the manmade ecosystems do not replace the former biological diversity. Birdsfoot sagebrush, Douglas rabbitbrush and skunkbrush sumac are three community types which occur in small patches on specialized substrates and which are being decreased in both size and extent due to coal mining.

The uranium mine is located mainly in the sagebrush matrix. The bentonite mines are located in the woodland-sagebrush mosaic of the Upton-Osage areas and scoria pits form very small patches of disturbance in scattered locations, mostly near the coal mines.

Cumulative impacts from the mining activities are restricted to very specific locations because of the distribution of the locatable minerals. In contrast, oil and gas leasing cumulative effects, while not affecting as many actual acres as mineral mining, affect the whole landscape because the roads, drill sites and pipelines accumulate as many small sites and corridors over the entire area. Thus, the impacts



- Coal Mine Lease Boundaries
- Bentonite Mine General Areas
- Uranium Mine Lease Boundary
- Scoria Pits

**Scoria Pits:**

1. Steckley Road Pit
2. School Creek Pit
3. Dull Center Pit
- 4a. Lady Bird Pit
- 4b. Lady Bird Pit
5. Keyton Pit
6. Down-by-the Railroad Pit
7. Beckwith Pit
8. Wyoming Highway Dept. Pit
9. Wyoming Highway Dept. Pit

Source: Douglas Ranger District  
Maps and Files, 1992

**FIGURE 6.1 LOCATIONS OF COAL, OIL AND BENTONITE MINES AND SCORIA OR SAND PITS**

to landscape, community, species and genetic biological diversity are inherently different because of the different spatial patterns of the activities.

From 1986 through near present, about 37 wells were drilled in the TBNG. Of these, only 7 were producing wells. The individual well sites averaged about 73,000 square feet or between 1.5 to 2.0 acres each. New roads to the sites usually affect 0.36 miles distance on federal surfaces. (A factor of 1.455 acres per mile of road may be used for low-specification road disturbance estimates). The gas pipelines have a 20 feet ROW and usually average just under 1000 feet distance on National Grassland surfaces. For each well site, one can estimate the usual area affected by the disturbance.

The MBNF staff estimates between 10 to 20 wells per year (or less) would normally be constructed (based on previous APDs). On a cumulative basis then, one can predict that between 20 and 50 acres of soil-plant (biological) resource would be disturbed yearly. In Plant Community Development on Petroleum Drill Sites in Northwestern Wyoming, Smith and others (1988) found that "Both soils and vegetation were altered by drilling activities. It was also found that all of the drilling-activity disturbed sites had successional different vegetation than the undisturbed sites. The sagebrush disturbed sites were progressing faster to undisturbed conditions as compared to the coniferous sites. Also, "seeding and establishment of introduced grass species on disturbed sites did not prevent natural recolonization of native species".

One study suggests that in stripped topsoil (stored for several years), the viable seed count will be decreased significantly, except that seed within the stored-topsoil surface. Similarly soil biological diversity, expressed as the number of plant species (richness) represented may also decrease in that time period (Dickie, et al, 1988). The stored topsoil seed bank can be maintained largely intact, if the storage period is no longer than a few months. Soil mycorrhizal components are also diminished in stored soils.

Reclamation is required for oil and gas sites and pipelines as well as for locatable mineral mining. Reclamation generally results in a change in biological diversity and simplification of plant communities.

For a discussion of longer-term effects of soil-biological resource, refer to Schafer, et.al. (1980). Reclaimed mine sites were examined one (1) to fifty years after reclamation. The morphology and genesis of the minesoils were found to have unique morphological properties. "Organic C content from 0-10 cm soil depth reached levels found in natural soils within 30 years..." The equilibrium of the 20-50 cm depth may take another 400 years or so. "Litter accumulation was common under pioneer vegetation on minesoils resulting in wide C:N ratios; reduction in available N; successional stagnation; and reduced plant community production. Soluble salts were leached downward in minesoils in tens of years, but thousands of years will probably be required for carbonate removal to occur in the upper 50 cm. Soil structure developed more quickly near the soil surface (10-50 years)

than below 10 cm (50-200 years), and was attained sooner in clayey than in sandy mine soils. Many characteristics of mine soils are expected to always be different from natural soils. Well-designed mine soils can be highly productive, however, in a few cases perhaps exceeding the potential of natural soils" (Schafer 1980).

Mitigation measures applied at the APD stage are contained in Appendix E of the DEIS. Rehabilitation measures are designed to stabilize soils and to reclaim the sites to productive rangeland and/or wildlife habitat. Under leasing Alternatives, rehabilitation of disturbed lands, whether linear or spatial, will emphasize "natural" or somewhat pre-existing conditions. Cut and fill areas will be re-contoured to a specified gradient consistent with the natural landscape.

Creation of landform diversity enhances potential for biological diversity when reclaiming disturbed lands. Use of native grass, forb or shrub species will be emphasized, as will be non-competing or non-increasing annuals. The following guidelines are from Edwards and Sullivan 1992, Sample Mitigation Measures which may be Applied at the APD Development Stage:

"Recontour disturbed areas to roughly pre-existing topographical conditions, unless otherwise approved by the FS Administrator. The reclaimed area must be meta-stable and not have large rills (or gullies) evident.

"Residual highwalls or bluffs (if applicable) may be approved on a case-by-case basis by the FS Administrator.

"Insure that mass wasting potential is minimized (meta-stable) or the potential is at least similar or better to pre-existing conditions.

"Establish an acceptable level of long-term visual quality by mitigating the visual contrast created by surface disturbance and the reclamation. Soil colors exposed by cut slopes shall meet visual requirements (post rehabilitation) as mandated by the FS Administrator. The reclaimed landscape should have characteristics that approximate the visual quality of the adjacent area with regard to location, scale, shape, color, and orientation of major landscape features. The reclaimed landscape should meet the needs of the post disturbance land use. Further information is found in LANDSCAPE DESIGN GUIDELINES.

"The Standard Lease Terms require that the operator '...conducts operations in a manner that minimizes adverse impacts to the land, air and water...and other resources...' (40CFR 1505.2 and 1508.20).

"Seeding: "The following species are generally approved. Other seed mixes may be approved or required by the FS Administrator:

*Artemisia frigida*  
*Rosa woodsii*  
*Regreen (lingering annual)*  
*Agropyron smithii*  
*Stipa viridula*  
*Bouteloua gracilis*  
*Eurotia lanata*  
*Artemisia ludoviciana*

Grazing of domestic livestock has created long-standing and pervasive changes to the biological diversity of the Thunder Basin National Grassland, affecting plant community composition, seral stage, vegetation condition, nutrient cycles, biomass production, and ecosystem energy flows for both terrestrial and aquatic ecosystems. Oil and gas leasing is not expected to significantly change the patterns already in place due to livestock grazing. Livestock grazing affects landscape, community and species biological diversity by direct, differential impacts on plant and animal species. These effects aggregate through the community and landscape levels over all land areas, as contrasted with the landscape wide-patch and corridor effects of oil and gas leasing and concentrated patch effects of coal, bentonite and uranium mining.

Fire suppression and use of herbicides are two other contributing factors to cumulative effects on biological diversity. Oil and gas leasing is not expected to alter the patterns from these activities.

Hunting and animal damage control affect the population structure and distribution of specific animal species. Oil and gas leasing is not expected to alter patterns created by these ongoing activities.

Perhaps the most important cumulative effect of oil and gas leasing is the increase in roaded areas and drill pad sites which fragment communities and landscapes. While these activities are not expected to cause serious disruption at the species level, especially with the application of CSU and timing stipulations to protect wildlife species of concern, they do physically fragment communities and landscapes. The total spectrum of effects of this fragmentation is not known.

Consideration of these cumulative effects on the range of natural variability of seral stages and community types for the matrix and patches; and retention of the existing biological diversity and ecological integrity for identified patches of special biological diversity suggests that a combination of Coarse and Fine Filter Approaches is appropriate.

The evaluation of the Alternatives proposed in the DEIS with regard to mitigation of cumulative effects on oil and gas leasing on biological diversity is the same as for direct and indirect effects discussed in the previous chapter. Alternative 4 of the DEIS was the preferred Alternative for biological diversity considerations and we recommend some adjustments in the boundaries of the NSO areas and addition of an another area.



## **CHAPTER VII**

### **RECOMMENDATIONS FOR MITIGATING EFFECTS OF OIL AND GAS LEASING ON BIOLOGICAL DIVERSITY**

#### **INTRODUCTION**

The specific recommendations in this chapter are based on an analysis of the environmental consequences of oil and gas leasing on biological diversity at the landscape and community (Coarse Filter) and species and genetic (Fine Filter) levels. No impacts on biological diversity are anticipated at the genetic level.

A combination of Coarse and Fine Filter Approaches is recommended to maintain biological diversity. The recommendations for perpetuation of biological diversity are based on:

- Retention of the existing biological diversity and ecological integrity for identified patches of special biological diversity;
- Consideration of direct and indirect environmental consequences and cumulative effects of oil and gas leasing on the range of natural variability of seral stages and community types for the matrix and patches,
- Special consideration for ecotones (edges) where there is high species richness
- Protection of the interactions of communities with each other
- Prevention of loss of, or high impacts to, communities where community interactions are unknown
- Prevention of the loss of multiple-use management opportunities because of disruption or destruction of uncommon communities
- Prevention of damage to existing uncommon communities
- Consideration of needs of specific species
- Perpetuation of small and/or isolated populations
- Allowing oil and gas exploration and development within the interior of the extensive matrix where the overall impact is expected to be less

The Coarse Filter Approach is to recommend No Surface Occupancy Stipulations for several landscape patches with special biological diversity characteristics. The Fine Filter Approach is to apply Controlled Surface Use and Timing Stipulations in conjunction with Forest Plan Regulations and Guidelines, EPA and Wyoming Water Quality Regulations and the terms in the

standard lease for protection of specific species and small patches and corridors.

The biological diversity in riparian corridors less than 400 m wide, and playas, is expected to be protected adequately by requirements for protection of wetland, riparian and wildlife areas in the Forest Plan, by constraints for drill pad siting in the lease terms, and special stipulations. There should not be negative impacts to aquatic biological diversity if EPA regulations and Forest Plan standards and guidelines are followed.

Biological diversity in the matrix of sagebrush shrub-steppe, sagebrush steppe and grassland, is not expected to be significantly disturbed by oil and gas leasing activities. The direct impacts will consist mainly of small patches from drill pad sites, road corridors and pipeline corridors. Reclamation of drill pad sites for these areas results in patches which will undergo secondary succession producing communities which integrate into the matrix in 10 to 20 years. Most direct and indirect impacts are related to the proliferation of roads.

Wildlife populations will be impacted locally in the matrix, but regulations protecting Threatened and Endangered species, and Forest Plan standards and guidelines together with lease term constraints, is expected to protect indicator and other managed species. The areas recommended for controlled surface use stipulations in Alternative 4 should adequately address biological diversity considerations for managed wildlife populations.

Cumulative impacts to biological diversity from oil and gas leasing are not expected to create significant negative effects when added to other ongoing land uses over time in the matrix.

In some areas with woodland vegetation, and areas of high relief, sensitive soils and uncommon vegetation types, negative impacts from oil and gas leasing can degrade ecological integrity and the values associated with biological diversity at landscape, community and species scales.

#### **RECOMMENDATIONS**

Alternative Four of the Draft EIS (leasing with standard and special stipulations, greater recreation emphasis) was the Preferred Alternative for biological diversity considerations. We recommend broadening it to include special stipulations to perpetuate biological diversity. Modification of previously proposed boundaries and additional areas for application of No Surface Occupancy stipulations are recommended for maintaining biological diversity.

Areas with important biological diversity characteristics at the landscape, community and species level, are generally coincident with areas that have high scenic and recreational value. In the Powder River Basin landscape, these are areas with discontinuous substrates, high relief, unique erosional forms and plant communities with shrub and tree components providing color, form and texture within the landscape matrix and which provide special habitat variety for animals. Thus, some areas previously identified in the DEIS for wildlife concerns, soil protection and recreational emphasis, and which have been recommended for restricted exploration and drilling

activities through Controlled Surface Use or No Occupancy stipulations, are some of the same areas identified in the biological diversity assessment.

Our recommendations for No Surface Occupancy protect areas where surface disturbance would directly affect landscape scale biological diversity for terrestrial plant and animal communities, terrestrial plant and animal species and the ecological integrity of specific landscape units on the Thunder Basin National Grassland.

Oil and gas production will always have the highest dollar value when compared to all other resources on the basis of small land areas (unit of land). Resource values related to biological diversity are usually based on larger land units involving areas with specific plant and animal communities and species. Dollar values can be placed on some of these resource values (for example hunting or fishing). It is difficult to place dollar values on non-commercial species or on ecological integrity of larger landscape units, yet these need to be included in decisions for land use. The results of the analysis concluded that physical surface disturbance and increased human presence would have greater impacts on some ecosystems than on others.

The total acreage recommended for No Surface Occupancy based on the biological diversity analysis is approximately 24,500 acres, or about 4.2% of the total acreage of the Thunder Basin National Grassland. The Miller Hills and most of Cow Creek Buttes are in areas forecast for low development potential for oil and gas (DEIS). The Downs area is in a medium development potential area. The Duck Creek area includes both medium and high development potential areas (Reasonable Foreseeable Development Model - DEIS). About 44% of the lands in this 4.2% recommendation are in areas with low development potential for oil and gas leasing. Within the approximately 1,800,000 acres inside the planning area boundary of the TBNG, the lands recommended for NSO total about 1%.

Low Development Potential	Acres	% of TBNG
Miller Hills	3,520 ac	0.6%
Cow Creek Buttes	6,970 ac	1.2%
Medium Development Potential		
Downs area	5,080 ac	0.8%
Medium or High Development Potential		
Duck Creek Breaks	8,960 ac	1.6%
Total	24,530 ac	4.2%

Exploration and development of oil and gas can denigrate biological diversity and ecological integrity of landscapes and communities in both short-term and long-term frameworks for certain ecosystems. In some ecosystems and landform contexts, effects of oil and gas development will have little short-term or long-term effects on biological diversity and landscape integrity because landforms are disturbed very little and succession erases the effects of mechanical disturbance. In other ecosystems, the effects of mechanical surface disturbance severely impact

species, community and landscape biological diversity in both the short and long term.

### **The Rochelle Hills and Upton Osage Areas**

Application of Controlled Surface Use and Timing Limitation stipulations, Forest Plan Standards and Guidelines and the constraints in the lease terms were deemed adequate for protection of biological diversity for the Upton-Osage and Rochelle Hills Areas. Controlled surface use areas have been identified in the DEIS. Patch size characteristics and the somewhat developed condition of these areas suggest that the existing level of biological diversity can be maintained using the Fine Filter Approach features of the Special Stipulations in conjunction with regulations that protect against mass wasting.

### **Inventoried Semi-Primitive Areas**

Inventoried semi-primitive areas (ISPM) are identified based on criteria in the Recreational Opportunities Spectrum Guidelines (ROS) (FS Manual 2300). These criteria include visual values and road development. Four ISPM areas were identified: 1. The Miller Hills 2. Cow Creek Buttes 3. Dugout 4. Duck Creek. Three of these ISPM areas; Miller Hills, Cow Creek Buttes and Duck Creek have been proposed for No Surface Occupancy (NSO) based on recreational opportunities spectrum (ROS) criteria. The Downs area was assessed for an ISPM, but was classified as a roaded rural area based on the presence of one road, oil and gas well, which exceeded ISPM standards.

The three areas recommended for No Surface Occupancy using ROS guidelines make important contributions to biological diversity at the landscape, community and species levels. These three areas (Miller Hills, Cow Creek Buttes and Duck Creek Breaks) were also identified as having special biological diversity using the criteria listed in Chapter 4. Additionally we recommend boundary adjustments to the Miller Hills ISPM - NSO area; an additional NSO area near the the Duck Creek ISPM - NSO area and application of No Surface Occupancy to the Downs area. The reasons are discussed below.

#### **1. The Miller Hills**

The Miller Hills, with its scoria buttes and remnant sandstone, are an island of woodland communities. Shrublands are found in the canyons on the north side of the Miller Hills around the base of the elevated plateau. The woodlands provide important habitat for bald eagle winter roosts. This is especially important because similar habitat in the Rochelle Hills, which is also an isolated woodland, was lost in the 1988 fire.

Figure 7.1 shows the recommendation for adjustment to the ISPM-NSO boundary. This recommendation is to place the NSO boundary to include areas north of the Forest boundary down to the 4600 foot contour line so that more areas of topographic relief and more acreage of shrubland communities will be included. This unites the woodland-bearing communities in an NSO area that also includes a diversity of shrubland types and avoids fragmentation of quality habitat. It also provides a larger area free of disturbance for bald eagles. The total acreage is approximately 3520 acres.

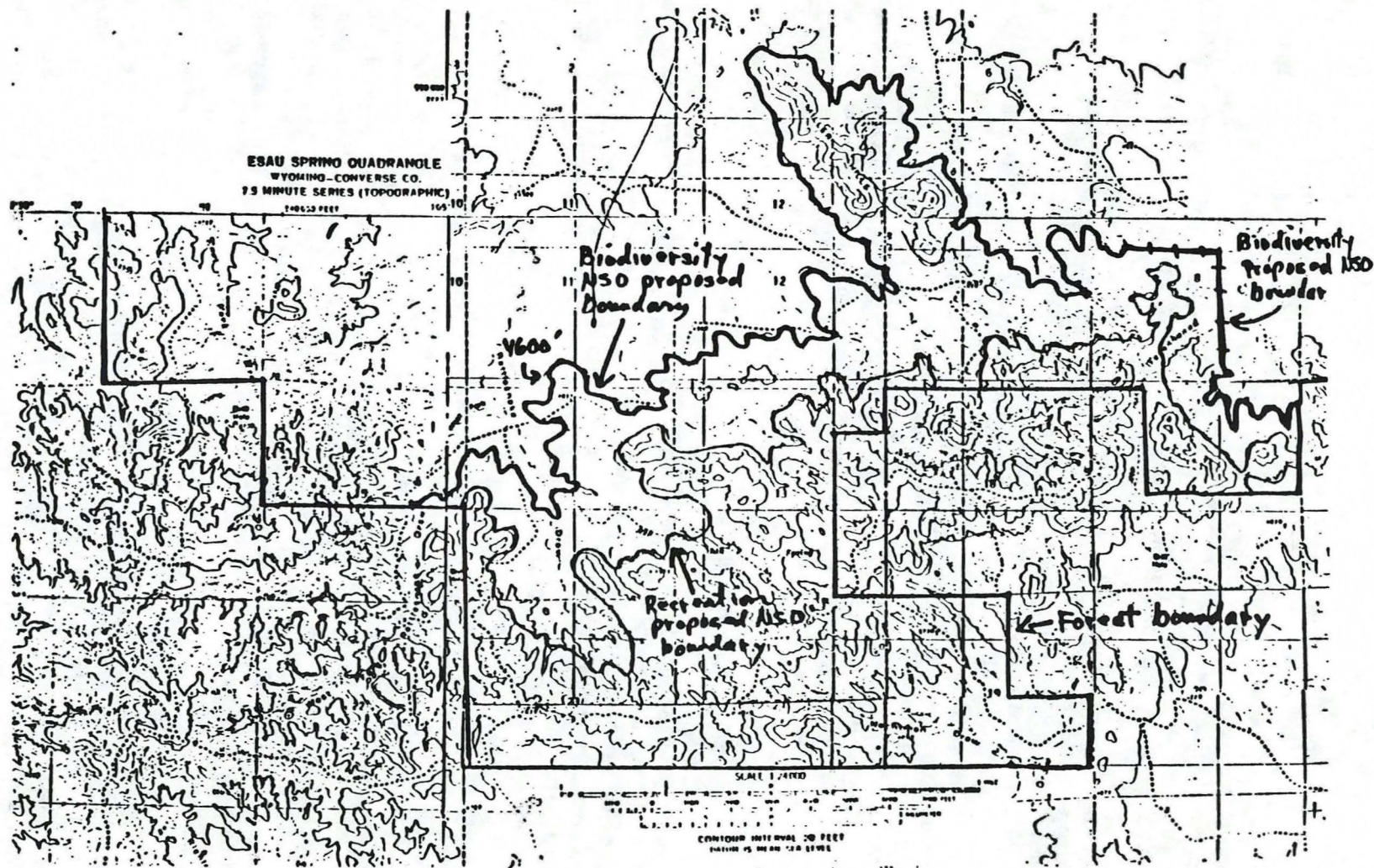


FIGURE 7.1 Miller Hills Biological Diversity No Surface Occupancy Recommendation

1 mile

North

## **2. Cow Creek Buttes**

The ISPM - NSO boundary for Cow Creek Buttes is adequate for inclusion of important biological diversity characteristics of this area with the exception that we recommend moving the northwest boundary to the road. We recommend No Surface Occupancy boundary for reasons of biological diversity to be the same as for the ISPM - NSO. (Figure 7.2)

The northern part of this area has scoria landforms which support remnant coniferous woodlands of ponderosa pine and juniper. These scoria buttes are near the southernmost extent of scoria buttes in Wyoming. Several shrubland community types are represented here also. Cow Creek Buttes is different geologically. A resistant sandstone cap has protected softer strata of shale, sandstone, claystone and siltstone from eroding. These buttes and the nearby badlands, included in the ISPM-NSO boundary, contain a good representation of plant communities which are not common in the Thunder Basin National Grassland landscape; they are vegetated with plant species which do not occur in large numbers throughout the administrative unit and they generally have good quality habitat. The area included in our recommendation is 6,970 acres.

## **3. Duck Creek Breaks**

The area within the ISPM - NSO boundary in the Duck Creek area contains ponderosa pine woodland, several kinds of shrubland, little bluestem grassland and patches of sagebrush steppe. This area has many community types occurring together which differ sharply in their structural and species composition characteristics. The area is in excellent condition and provides good quality habitat.

We support No Surface Occupancy within the ISPM-NSO boundary. We also recommend the addition of 792 acres of NFS to the northeast (Sections 2, the east half of Section 3 and part of Section 4) (Figure 7.3). This additional NSO area is recommended to preserve the ecological integrity of this area. Some vegetation communities in this additional area are unique to the Thunder Basin National Grassland. Woody draws, aspen groves, large ponderosa pine trees and remnant tall-grass prairie species (big bluestem) occur here. The area is characterized by not only the excellent condition and unusual plant species composition, but also by its wholeness and lack of surface disturbance from human activity. The total acreage is 8960 acres.

## **4. Downs Area**

The Downs area (Figure 7.4) is recommended as a No Surface Occupancy area in addition to the three ISPM areas discussed above. The Downs area is an outstanding area of badlands formed in the Lebo shale member of the Fort Union Formation. There are canyons and rugged badlands which are unique to the Thunder Basin National Grasslands. The landscape has a high degree of patchiness due to the substrate and many shrubland communities occur here. Outstanding among these is the occurrence of substantial patches of the birdsfoot sagebrush community. This uncommon community type grows only on specialized clay and shale exposures. It is found on flat to gently sloping surfaces. In this rugged topography, birdsfoot sagebrush is at high risk

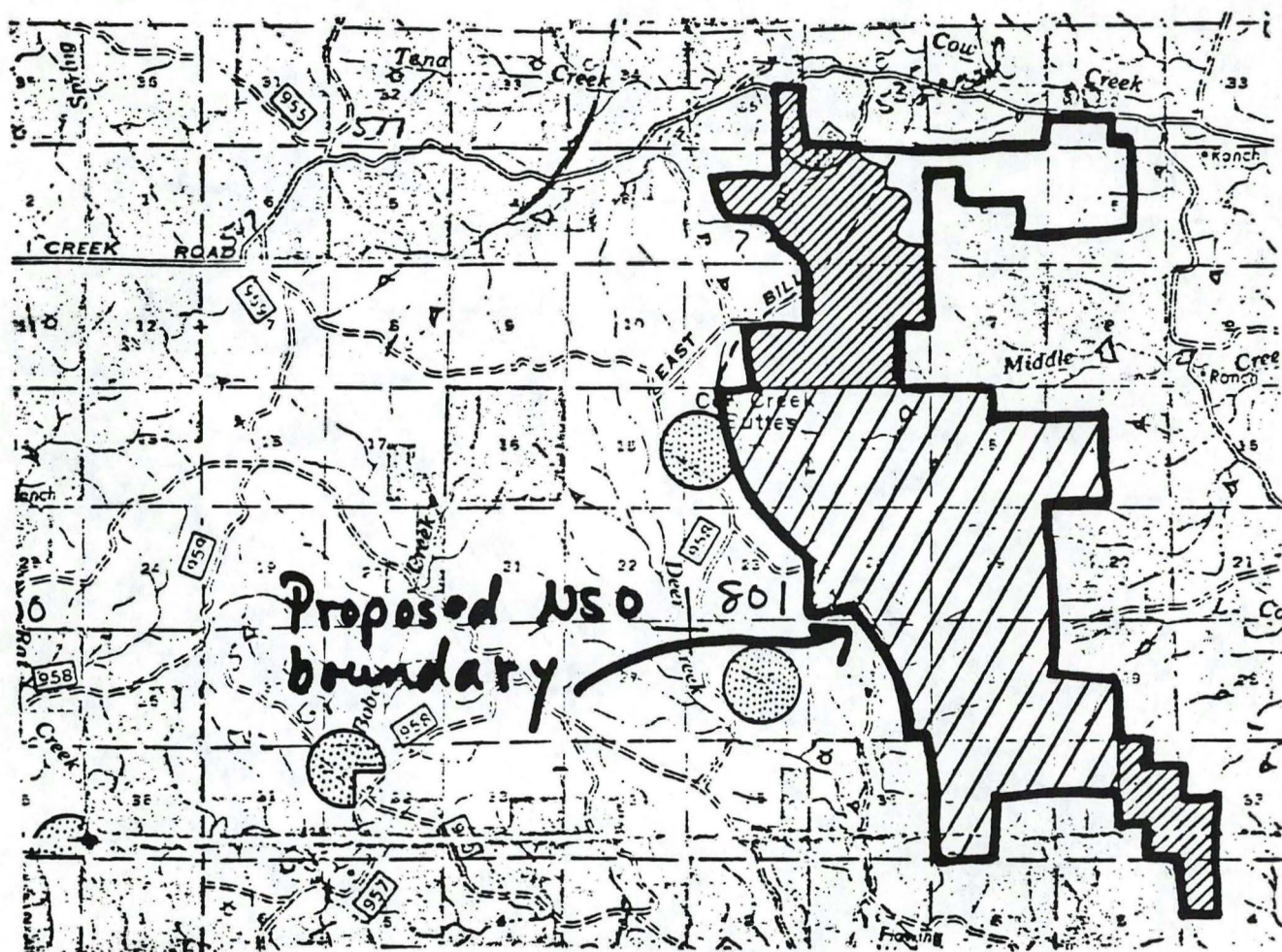
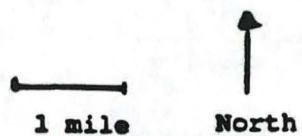


FIGURE 7.2 Cow Creek Buttes Biological Diversity No Surface Occupancy Recommendation





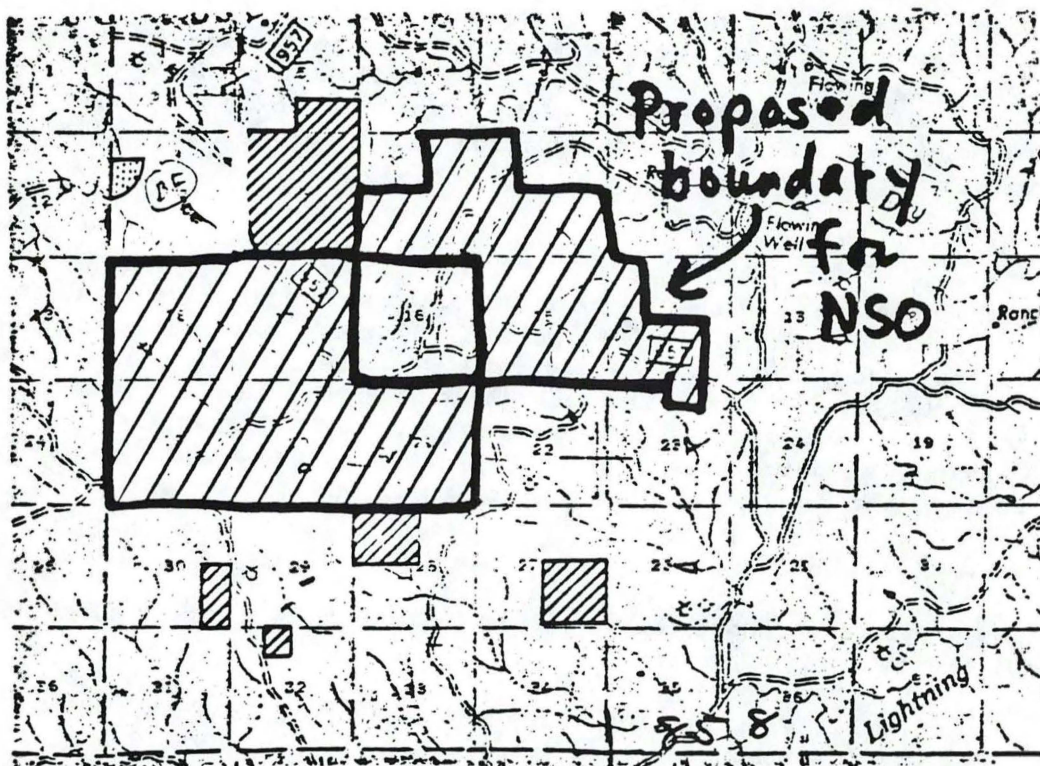
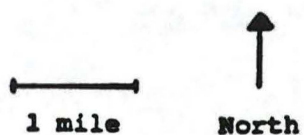


FIGURE 7.4 Down's Area Biological Diversity No Surface Occupancy Recommendation



for removal due to oil and gas leasing operations, because it occurs on sites highly suitable for drill pads. The total acreage here is 5080 acres.

In addition to the presence of the birdsfoot sagebrush community, which is a species and community level consideration, this landscape contributes significantly to the biological diversity of the Thunder Basin National Grassland because of its unusual landforms and substrates. It is especially sensitive to soil erosion if the surface is disturbed and has been identified for potential NSO on 75% of the area because of potential Mass Wasting (Mass Wasting Map - Edwards, 1992 DEIS). Because of the unusual landforms and specialized plant communities, surface disturbance from Oil and Gas leasing (roads and drill pads) will cause more changes to the natural condition, than these activities would in sagebrush steppe, grassland or shrublands on less rugged terrain. The habitat here is of exceptionally good quality for wildlife. This area has a high degree of ecological integrity and is especially susceptible to degradation of biological diversity from surface-disturbing uses.

#### **Dugout**

The Dugout area was the fourth inventoried semi-primitive area. It is mainly a shrubland on a low-relief surface. This area is not recommended for No Surface Occupancy. Similar terrain is widespread in nearby parts of the Cheyenne River Valley. The main kinds of shrubland plant communities found here are represented in the Cow Creek Buttes, Miller Hills and Downs area. Forest Plan guidelines and constraints in lease terms are sufficient to protect the biological diversity of this area.

#### **SUMMARY**

The areas recommended for No Surface Occupancy as a result of the Biological Diversity Analysis are:

1. The Miller Hills (part of ISPM area) (Map 7.1) approx 3520 ac
2. Cow Creek Buttes (ISPM area) (Map 7.2) approx 6,970 ac
3. Duck Creek (ISPM area and additional area) (Map 7.3) approx 8,960 ac
4. Downs area (Map 7.4) approx 5080 ac

Use of Controlled Surface Use and Timing Limitation (Fine Filter Approach) as identified in Alternative Four, are also recommended to accompany the Coarse Filter Strategy (No Surface Occupancy) to comprehensively address biological diversity concerns for oil and gas leasing on Thunder Basin National Grassland.

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## APPENDIX



# LIST OF PREPARERS

## United States Department of Agriculture, Forest Service

Name Experience	Title	Credentials	Years
Tim Byer	District Wildlife Biologist	B.S. wildlife management	9
Malcom Edwards	Forest Soil and Air Scientist	B.S. in soils	16
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Judy von Ahlefeldt Team Leader	Forest Ecologist	PhD in landscape ecology	2

Special thanks to Marla Wertz for assistance in preparing the illustrations.



## GLOSSARY

**allochthonous** - originating elsewhere, with reference to energy or materials for an ecosystem

**autochthonous** - originating within, with reference to energy or materials for an ecosystem

**benthic** - an adjective referring to the bottom of a body of water, i.e. benthic organisms

**community** - a group of interacting populations occupying a defined area, varying in scale from a few square feet to several hundred acres.

**corridor** - a landscape element that connects similar patches through a matrix or an aggregation of patches. Rivers and pipelines are corridors.

**disjunct species** - a species that has a population or populations disconnected from its main home range.

**ecotone** - a transition area between different ecosystems. Ecotones can vary in scale from sharp ecotones between community types to broad ecotones on the landscape scale.

**endemic** - native to a particular place; used to refer to plants and animals

**fragmentation** - a process (or condition), which causes (or describes) the breakup of the matrix, isolation of patches or discontinuity in a corridor. Fragmentation affects composition, structure, process and function of ecosystems at all scales.

**landscape** - a heterogeneous land area composed of a cluster of interacting ecosystems. Landscapes can vary in scale from a few hundred acres to many thousands of acres.

**macroinvertebrate** - any of the larger invertebrate animals, many belong to the molluscs, arthropod or worm taxonomic groups.

**matrix** - a term referring to the vegetation that is most contiguous in a landscape. The matrix has strong connectivity characteristics and exerts strong control over ecosystem processes and functions.

**patches** - areas of vegetation that are relatively homogeneous internally but differ from their surroundings (the matrix or other patches)

**remnant** - a term which refers to a population of organisms which remains after the main population has been exterminated.

## **GLOSSARY (concl.)**

**riparian** - referring to an area of land with vegetation different than upland, because of supplemental water. On the Thunder Basin National Grassland riparian areas may be associated with drainages, springs, playas and reservoirs.

**steppe** - a dry grassland

**succession** - a process which is described by replacement of one community by another over time

**TABLE 3 MAJOR SOIL TYPES ON THUNDER BASIN NATIONAL GRASSLAND AND NEARBY AREAS**

Order	Great Group or Subgroup	Series	Order	Great Group or Subgroup	Series
ALFISOLS	Typic Eutrobora	Gateson Variant Citadel Lakoa Wages Variant	ARIDISOLS	Camborthids	Cadoma Heldt Rekop (Variant) Silhouette Snomo Turnback Thermopolis Twotop Winler Zigweid
	Mollic Cryoborals	Stovho (& Variant)			
MOLLISOLS	Maploborolls	Chinook Cordeston Paunsaugunt Pesowyo	ENTISOLS	Paleargids	Bidman Demar Parmaleed
	Argiborolls	Nilrap Moorcool Nunston Onita Variant Reicess Sugakool Tanna Vassett			
	Aridic Maplustolls	Alice Variant Maggin		Torriorthents	Bahl Bone Colhill Colnevee(& variant) Colsavage Crownest Grummit Gypnevee Variant Milight Keeline Kishona Orella Petrie Samday Samoist Shingle Tassell (& variant) Theedle Topeman Turnercrest Wibeux
INCEPTISOLS	Maplaquepts Aeric Maplaquepts	Higgins Variant			
ARIDISOLS	Ustollic Maplargids	Bowbac Cambria (& Variant) Cushman Forkwood (& Variant) Miland Renohill Sear Terro Ulm Vonalee Worf Worfka Regnaps			
	Borollic Maplargids			Torrifluvents	Clarkelen(+ variant) Draknab Haverdad Lohmiller Stetter
	Natragids	Absted Arvada Lohsman		Psammments	Dwyer McCaffery Orpha Tullock

Source: USDA SCS Soil Survey Reports for Northern Converse County and Campbell County. See the reports for extent of the Soil Series.

TABLE 1

## VEGETATION NOMENCLATURE

Acronym	PLANTS* Database name	Synonym	Acronym	PLANTS Database name	Synonym
Arca13	Artemisia cana		Pipo	Pinus ponderosa	
Arpe6	Artemisia pedatifida		Pode3	Populus deltoides	Populus sargentii
Artr	Artemisia tridentata		Pssp6	Pseudoroegneria spicata	Agropyron spicatum
Atca2	Atriplex canescens		Rhtr	Rhus trilobata	
Bogr2	Bouteloua gracilis		Save4	Sarcobatus vermiculatus	
Cafi	Carex filifolia		Scsc	Schizachyrium scoparium	Andropogon scoparius
Calo	Calamovilfa longifolia		Stco4	Stipa comata	
Chvi8	Chrysothamnus viscidiflorus		Stvi4	Stipa viridula	
Jusc2	Juniperus scopulorum		Syoc	Symphoricarpos occidentalis	
Pasm	Pascopyrum smithii	Agropyron smithii	Yugl	Yucca glauca	

\*USDA Soil Conservation Service. 1992. PLANTS - Plant list of Accepted Nomenclature, Taxonomy, & Symbols. Alphabetical Listing Report. National Plant Materials Center, Beltsville, MD

**TABLE 2 VEGETATION NOMENCLATURE FOR ADDITIONAL VEGETATION CLASSIFICATION UNITS**

Acronym	PLANTS* Database name	Synonyms	Common Name
Ange	<i>Andropogon gerardii</i>		big bluestem
Arca13	<i>Artemisia cana</i>		silver sagebrush
Artr	<i>Artemisia tridentata</i>		big sagebrush
Atca2	<i>Atriplex canescens</i>		fourwing saltbush
Bocu	<i>Bouteloua curtipendula</i>		sideoats grama
Bogr2	<i>Bouteloua gracilis</i>		blue grama
Buda	<i>Buchloe dactyloides</i>		buffalograss
Cadu6	<i>Carex duriuscula</i>	<i>Carex eleocharis</i>	needleleaf sedge
Cafi	<i>Carex filifolia</i>		threadleaf sedge
Cainh2	<i>Carex inops</i>	<i>Carex heliophila</i>	sun sedge
Disp	<i>Distichlis spicata</i>		inland saltgrass
Elac	<i>Eleocharis acicularis</i>		needle spikesedge
Frpe	<i>Fraxinus pennsylvanica</i>		green ash
Jusc2	<i>Juniperus scopulorum</i>		Rocky Mountain juniper
Krla2	<i>Krascheninnikovia lanata</i>		winterfat
Leci4	<i>Leymus cinereus</i>		basin wildrye
Mare11	<i>Mahonia repens</i>		Oregongrape
Mucu3	<i>Muhlenbergia cuspidata</i>		plains muhly
Pasm	<i>Pascopyrum smithii</i>	<i>Agropyron spicatum</i>	western wheatgrass
Pipo	<i>Pinus ponderosa</i>		ponderosa pine
Pode3	<i>Populus deltoides</i>		Plains cottonwood
Pose	<i>Poa secunda</i>		Sandberg bluegrass
Potr5	<i>Populus tremuloides</i>		quaking aspen
Prvi	<i>Prunus virginiana</i>		common chokecherry
Pssp6	<i>Pseudogoepernia spicata</i>	<i>Agropyron spicatum</i>	bluebunch wheatgrass
Punu2	<i>Puccinellia nuttalliana</i>	<i>Puccinellia nuttallii</i>	Nuttall alkaligrass
Save4	<i>Sarcobatus vermiculatus</i>		black greasewood
Scam2	<i>Scirpus americanus</i>		American bulrush
Scsc	<i>Schizachyrium scoparium</i>		little bluestem
Spai	<i>Sporobolus airoides</i>		alkali sacaton
Stco4	<i>Stipa comata</i>		needleandthread
Syoc	<i>Symphoricarpos occidentalis</i>		western snowberry

USDA Soil Conservation Service. 1992. PLANTS - Plant List of Accepted Nomenclature, Taxonomy, and Symbols. Alphabetical Listing Report. National Plant Materials Center, Beltsville, MD

From: Judy von Ahlefeldt  
Forest Ecologist  
Medicine Bow National Forest  
January, 1993

To:

Attached please find documents which I have prepared for use on the MBNF as support documents for the riparian initiative (riparian polygon mapping); as reference documents for the Plant Association Field for the datasheets for Stage II Inventory and the RIS database; and for use in describing biological diversity for vegetation at the community and landscape scales. Plant species lists for the Sierra Madre and Medicine Bow Mountains, the Sherman Mountains and the northern unit of the Laramie Mountains are in preparation as support documents for the community type lists.

The attachments include:

1. Plant Community types - MBNF from Johnston (1987) and Alexander et al. (1986). This list consists of community types actually described from the MBNF or considered to occur here in Johnston (1987).
2. Interim List of Plant Community Types
  - A. References and discussion
  - B. Name Dictionary for MBNF Community Types
  - C. The list of community types stratified according to the classification presented (in 3) below.
3. Working Vegetation Classification Hierarchy for IRI Mapping on the MBNF

These are provided for your information and in the interest of sharing knowledge and methods as our information base is expanded and reorganized in the future.

**PLANT COMMUNITY TYPES - MBNF- FROM JOHNSTON (1987)  
AND Alexander et al (1986)**

PLANTS ACRONYM	JOHNSTON ACRONYM
<b>CONIFEROUS FOREST</b>	
(Upland)	
Abla-Pien/MOSS	Abla-Pien1/moss
Abla-Pien/Vace	Abla-Pien1/Vace
Abla-Pien/Vasc	Abla-Pien1/Vasc
Abla-Pien/Cage2	Abla-Pien1/Cage1
Abla-Pien/Caru3	Abla-Pien1/Caru1
Pico/Vasc	Pico/Vasc
Pico/Cage2	Pico/Cage1
Pico/Caro5	Pico/Caro3
Pico/Juco6	Pico/Juco
Pico/Arav	Pico/Arad
Pico/Shca	Pico/Shca
Pifl2/Leki2	Pifl/Leki
Pifl2/Juco6	Pifl/Juco
Pipo/Caro5	Pipo/Caro3
Pipo/Cage2	Pipo/Cage1
Pipo/Aruv	Pipo/Arad
Psme/Phmo4	Psme/Phmo
(Riparian)	
Alba-Pien/Caca4	Abla-Pien1/Caca
Pipu/Arco9	Pipu/Arco2
<b>DECIDUOUS FOREST</b>	
(Upland)	
Potr5/Cage2	Potr1/Cage1
Potr5/Lala3	Potr1/Lale
Potr5/Juco6	Potr1/Juco
Potr5/Caro5	Potr1/Caro3
(Riparian)	
Potr5/LIGUS	Potr1/LIGU
Potr5/Amal2-Prvi	Potr1/Amal-Pavi
Poan3/Saex-Beoc2	Poan3/Saex-Befo
Pofr2/Syoc-Saex	Posa/Syoc-Saex
<b>WOODLAND</b>	
(Upland)	
Jusc2-Pssp	Jusc-Rosp
Quga Series	Quga
<b>SHRUBLAND</b>	
(Upland)	
AMELA/Cage2	AMEL/Cage1
AMELA/Putr2-Pssp	AMEL/Putr-Rosp
AMELA/Syor1-Artr2	AMEL/Syor1-Artrv
Artr2/Feid	Artr1-Feid
Artr2/Pssp	Artrv-Rosp
Artr2/Stco4	Artr1-Stco1
Artr2-Putr2/Agda	Artrv-Putr/Elda

Putr2-Artr2/Feid  
Putr2-Artr2/Pssp

Cemo2/Feid  
Cemo/Pssp

(Riparian - non-willow)  
Alin2-Beoc2/SALIX

Pofr4/Dece

(Riparian - Willow)  
Tall Willow  
Sage2-SALIX/Caca4

Saex-SALIX/POA  
Saex-SALIX/Caca4-Eqar

Sabo2-SALIX/Caro6  
Sabo2-SALIX/Caca4

Sapl2/Caaq  
Sage2/Popa2

Salu2/Eqar

Short Willow  
Sawo/Caro3  
Sawo/Dece  
Sawo/Frvi  
Sawo/Caca4  
Sawo/Caaq

Putr-Artrv/Feid  
Putr-Artr2/Rosp

Cemo/Feid  
Cemo/Rosp

Alint-Befo/SALI

Pefl/Dece

Sage-SALI/Caca

Saex-SALI/POA  
Saex-SALI/Caca-Eqar

Sabot-SALI/Caut  
Sabot-SALI/Caca

Saphp/Caaq

Salu/Eqar

Sawo/Caut  
Sawo/Dece  
Sawo/Frvi  
Sawo/Caca  
Sawo/Caaq

#### FORBLAND

(Upland)  
Geror-TRIFO/Dece

Geror/Trda2

Sipr/Caeb

Acro-TRIF/Dece

Acro/Trda

Sipr/Caeb

#### GRASSLAND

(Upland)  
Dece/Geror

Stco4/Caeb  
Stco4/Bogr

Dapa2/Feid

Pssp/Pose

(Riparian)  
Elpa3/CAREX

Dece/CAREX

Caaq/Caro6

Cami7/Dece

Casi2/ Dece

Dece/Geror

Stcol/Caeb  
Stcol/Bogr

Dapa1/Feid

Rosp/Pose

Elpa/CARE

Dece/CARE

Caaq/Caut

Cami4/Dece

Casi/Dece

**INTERIM LIST OF PLANT COMMUNITY TYPES - MEDICINE BOW NATIONAL FOREST  
12/92**

Sierra Madre Range	Hayden District
Medicine Bow Range	Laramie District and Hayden District
Sherman Mountains	Laramie District
Laramie Range	Douglas District

Base List compiled from lists for the Medicine Bow National Forest in:  
Johnston, B.C. 1987. **Plant Associations of Region 2.** R2-ECOL-87-2  
Denver

Alexander, R.R., Hoffmann, G.R. and J.M. Wirsing. 1986. **Forest Vegetation of the Medicine Bow National Forest in Southeastern WY: A Habitat Type Classification.** RM-271 RMFRES Fort Collins, CO

\* indicates additional community types from:

Alexander, R.R. 1985. **Major Habitat Types, Community Types and Plant Communities in the Rocky Mountains.** GTR-RM-123 Fort Collins, CO

Cooper, D.J. 1990. **Ecology of Wetlands in Big Meadows, Rocky Mountain National Park.** USDI FWS Biological Report 90(15).

DeVelice, R.L., Ludwig, J.A., Moir, W.H. and F. Ronco, Jr. 1986. **A classification of Forest Habitat Types of Northern New Mexico and Southern Colorado.** GTR- RM-131. Fort Collins, CO

Hansen, P., Pfister, R., Joy, J., Svoboda, D., Boggs, K. Myers, L., Chadde, S. and J. Pierce. 1989. **Classification and Management of Riparian Sites in Southwestern Montana (SW MT)**  
Draft Version 2. Montana Riparian Assn School of Forestry U. of MT. Missoula

Hansen, P., Boggs, K., Pfister, R. and J. Joy. 1990. **Classification and Management of Riparian and Wetland Sites in Central and Eastern Montana. (CN MT)** Draft Version 2. Montana Riparian Assn, Montana Conservation Expt. Station, School of Forestry and U. of Mont. Missoula

**Integrated Riparian Evaluation Guide (R-4) 1992**

Johnston, B.C. 1987. **Plant Associations of Region 2.** R2-ECOL-87-2 Denver

Jones, G. 1992. **A Preliminary Classification of Riparian Vegetation Types of the Medicine Bow Range and the Sierra Madre.** Laramie

Acronym Symbols are from: **PLANTS - Plant List of Accepted Nomenclature, Taxonomy and Symbols Alphabetical Listing Report.** 1992. USDA Soil Conservation Service Beltsville, MD

Common names are mainly from: **Standardized Plant Names for Wyoming with automatic data processing codes.** (SCS) (1986). Some common names are from Johnston (1987).

This draft model for the vegetation of the Medicine Bow National Forest is based on a compilation of described community types from the above sources. Upland types are from Forest Service literature only, based on vegetation classifications for forest types throughout Region 2. Some community types found on the MBNF were not included in the report by Alexander et al (1986), but were described for other areas, in particular the Routt NF and the Arapaho-Roosevelt NF.

Many riparian community types have been added to the literature since Johnston (1987) was published. Selected community types from the sources listed above were included in this Interim List. It is likely that most vegetation types found on the Medicine Bow National Forest have been described in the literature. More community types will undoubtedly be added to this list as more becomes known about plant communities, and some adjustments are expected in the allocation between upland and riparian types, but in the meantime, this list should contain most of the major types on the Medicine Bow National Forest.

This list, utilizing existing information is not meant to denigrate the need for field work on classification on the Medicine Bow National Forest. Rather, it provides a needed communication framework using community types, until field studies can be done. Field studies will verify many of these types; may show that some are not found or are of minor importance or may add new types. This list may also suggest some community types which might be used for monitoring or for which additional information on production or other attributes could be measured. The accompanying classification hierarchy fits these community types into a classification framework which is crosswalked with the RIS database.

The classification used for this list is integrated with the RIS DATABASE structure to form an hierarchy from specific community types to larger landscape units of physiognomic types suitable for photointerpretation and mapping. The RIS database categories do not include all community types because RIS categories are formed partly on the basis of generic series, partly on environmental descriptions and partly on plant physiognomy. Nonetheless, specific instances where problems occur in fitting community types into RIS or fitting RIS into the comprehensive framework of Level 4 (proposed here), can be identified. Ways to modify or add RIS categories and/or to track this can be done within computer databases.

The intent of this model is to devise a way to fit vegetation classification, which is primarily taxonomic, floristic and ecological, in a practical way into the existing RIS database so that existing vegetation attributes of polygons can be labeled using consistent general categories descriptive of the landscape. Species and communities can be cleanly aggregated upward to form physiognomic vegetation units for descriptions of larger scales. The framework can be used equally well for description of existing vegetation in the CVU layer of IRI as well as for inference and polygon labeling for PNV for the CLU unit.

It should be pointed out that common water unit attributes, existing vegetation and the soils, geology and landscape components of the CLU are observable attributes of landscapes. PNV is an inferred category. It is not an attribute than can be observed for all polygons and at best serves as a model of vegetation behavior, not as a descriptor of landscapes mapped from aerial photos and ground truthing.

Many of the community types listed below were described as plant associations, with the inference that these are climax or at least late seral communities. They are described from actual sites and as such, qualify as community types. Many of the observable community types on the landscape are not climax or late seral, but they are necessary to ecosystem description and management. All plant

associations are community types but not all community types are plant associations. Much of the landscape is in seral stages where two species occur as co-dominants during succession. Especially important are aspen-lodgepole pine; aspen-subalpine fir; lodgepole pine-Engelmann spruce; lodgepole pine subalpine fir and lodgepole pine with both Engelmann spruce and subalpine fir. Additional community type descriptors need to be developed for these vegetation units which cover extensive acreages.

This document is a draft to provide a framework for imminent classification, mapping and riparian inventory projects on the Medicine Bow National Forest, which will be compatible with RIS and which are anticipated to be compatible with IRI as it develops. RIS vegetation categories not shown in this model could be added for use as appropriate to other National Forests or National Grasslands. New community types can also be fitted into this framework. The framework lends itself nicely to database fields and attribute files. It is anticipated that the riparian mapping to be done in FY93 would be done to level 4 with RIS categories at level 5 included as appropriate and available. If community type information (plant association) is available, it could be included; if not it could be added at a later time after ground-truthing or walkthrough inventories. This system provides a comprehensive framework into which any vegetation can be systematically nested because it uses all combinations of physiognomic descriptors which are part of community type (plant association) names (i.e. and overstory/understory method which also accommodates co-dominance).

There is a pertinent discussion about the differences between site classification for its own sake and using these for mapping functions in: Jones, R.K. 1990. Role of site classification in predicting the consequences of management on forest response. Pp. 19-38 IN: W.J. Dyck and C.A. Mees (Ed.). Impact of Intensive harvesting on Forest Site Productivity. Report No. 2. Forest Research Institute, Rotura, New Zealand. FRI Bulletin No. 159. Jones explains that a classification system can be used to characterize conditions about points on the ground or used as a legend (or key) for describing land features delineated on a map. It is hoped that the system suggested here, may facilitate integration of RIS, IRI and the large existing literature on classification and will provide a workable basis for polygon vegetation labels.

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1/93

with concurrence from:

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John Varner (IRI-DPD Model project)  
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# NAME DICTIONARY FOR MEDICINE BOW NATIONAL FOREST COMMUNITY TYPES

JVA 1/93

Scientific names are from the PLANTS (1992) Database List. Synonyms from Johnston (1987) are also listed. Common names are from: USDA Soil Conservation Service 1986. **Standardized Plant Names for Wyoming with Automatic Data-processing codes.** Casper, WY

PLANTS DB	Synonym	Scientific Name	Common Name
Acronym			
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TREES			
Abla		Abies lasiocarpa	subalpine fir
Acne2	Acne	Acer negundo	boxelder
Pien	Pien1	Picea engelmannii	Engelmann spruce
Pico		Pinus contorta	lodgepole pine
Pif12	Pif1	Pinus flexilis	limber pine
Pipo		Pinus ponderosa	ponderosa pine
Pipu		Picea pungens	blue spruce
Poan3		Populus angustifolia	narrowleaf cottonwood
Poba2	Poba	Populus balsamifera	balsam poplar
Podem	Posa	Populus deltoides	plains cottonwood
Potr5	Potr1	Populus tremuloides	quaking aspen
Psme		Pseudotsuga menziesii	Douglas-fir
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SHRUBS			
Alin2	Alint	Alnus tenuifolia	thinleaf alder
Amal2	Amal	Amelanchier alnifolia	Saskatoon serviceberry
AMELA	AMEL	Amelanchier spp.	serviceberry
Artr2	Artr(t,v,w)	Artemisia tridentata	big sagebrush
Aruv	Arad	Arctostaphylos uva-ursi	kinnikinnik
Beoc2	Befo	Betula occidentalis	water birch
Cemo2	Cemo	Cercocarpus montanus	true mountain mahogany
Ceve		Ceanothus velutinus	snowbrush ceanothus
Cose16	Swse	Cornus sericea	red-osier dogwood
Hodu		Holodiscus dumosus	ocean spray
Jaam4	Jaam	Jamesia americana	jamesia
Juco6	Juco	Juniperus communis	common juniper
Jusc2	Jusc	Juniperus scopulorum	Rocky Mountain juniper
Mare11	Mare	Mahonia repens	Oregon grape
Phmo4	Phmo	Physocarpus monogynus	mountain ninebark
Pofr4	Pefl	Potentilla fruticosa	shrubby cinquefoil
Prvi	Pavi	Prunus virginiana	common chokecherry
Putr2	Putr	Purshia tridentata	antelope bitterbrush
Quga	Quga	Quercus gambellii	Gambel oak
Rhtr	Rhart	Rhus trilobata	skunkbrush sumac
RIBES	RIBE	Ribes spp.	wild currant
Rice		Ribes cereum	wax currant
Rowo		Rosa woodsii	Wood's rose
Saar4	Saar	Salix arctica	arctic willow
Sabe2	Sade	Salix bebbiana	Bebb willow
Sab01		Salix boothii	Booth willow
Sabr	Sabr1	Salix brachycarpa	barrenground willow
Saca4		Salix candida	sageleaf willow
Sadr		Salix drummondiana	Drummond willow
Saex		Salix exigua	coyote willow
Sage2		Salix geyeriana	Geyer willow
Sagl1	Sagl1	Salix glauca	grayleaf willow

SALIX	SALI	Salix spp.	willow
Sala		Salix lasiandra	Pacific willow
Salu		Salix lutea	yellow willow
Sapl2	Saphp	Salix planifolia	planeleaf willow
Sawo		Salix wolfii	wolf willow
Shca		Shepherdia canadensis	russett buffaloberry
Syoc		Symphoricarpos occidentalis	western snowberry
Syor2	Syor1	Symphoricarpos oreophilus	whortleleaf snowberry
Vace		Vaccinium cespitosum	dwarf huckleberry
Vasc		Vaccinium scoparium	grouse whortlebery

#### FORBS

Acru2	Acru	Actaea rubra	red baneberry
Aqco		Aquilegia coerulea	Colorado columbine
Arco9	Arco2	Arnica cordifolia	heartleaf arnica
Arla8	Arla	Arnica latifolia	broadleaf arnica
Cale4	Cale1	Caltha leptosepala	elkslip marshmarigold
Caco6	Caco2	Cardamine cordifolia	heartleaf bittercress
Ciar4	Ciar1	Cirsium arvense	Canada thistle
Cisc3	Cisc	Cirsium scopulorum	alpine thistle
Droc	Droc	Dryas octopetala	mountain dryad
Erex4	Erex	Erigeron eximius	forest fleabane
Erpe3	Erpe1	Erigeron perigrinus	peregrine fleabane
Eqar		Equisetum arvense	field horsetail
Gatr3	Gatr2	Galium triflorum	sweetscented bedstraw
Geca3	Gecaa	Geranium caespitosum	Fremont geranium
Gevi2	Gevi	Geranium viscosissimum	sticky geranium
Geror	Acrot	Geum rossii	golden avens
Lala3	Lale	Lathyrus lanzwertii	aspen peavine
Libo3	Libo	Linnaea borealis	twinline
Lifi		Ligusticum filicinum	fernleaf ligusticum
Lipo		Ligusticum porteri	Porter ligusticum
LIGUS	LIGU	Ligusticum spp.	ligusticum
Luar		Lupinus argenteus	silvery lupine
Lupa8	Lupa3	Lupinus parviflorus	lodgepole lupine
Mast4	Smst	Maianthemum stellatum	wild lily-of-the-valley
Mear4		Mentha arvensis	field mint
Meci3	Meci	Mertensia ciliata	mountain bluebells
Migu	Migu	Mimulus guttatus	common monkeyflower
Osoc		Osmorhiza occidentalis	western sweetroot
Pamy		Paxistima myrsinites	myrtle paxistima
Pegr2	Pegr1	Pedicularis groenlandica	elephanthead lousewort
Pera	Pera3	Pedicularis racemosa	sickletop lousewort
Pobi6	Bibil	Polygonum bistortoides	America bistort
Podi2	Podi	Potentilla diversifolia	varileaf cinquefoil
Prpa2		Primula parryi	Parry primrose
Ptaq		Pteridium aquilinum	bracken fern
Raal		Ranunculus aslimaefolius	plainsleaf buttercup
Raaq		Ranunculus aquatilis	aquatic buttercup
Rona2		Rorippa nasturtium-aquaticum	watercress
Saod2	Miod	Saxifraga odolontoloma	brook saxifrage
Sede2	Sede	Selaginella densa	small clubmoss
Serh	Clrh1	Sedum rhodanthum	rose-crown
Setr		Senecio triangularis	arrowleaf groundsel
Sipr		Sibbaldia procumbens	creeping sibbaldia
Thfe	Thfel	Thalictrum fendleri	Fendler meadowrue
Trda2	Trda	Trifolium dasyphyllum	whiproot clover
TRIFO	TRIF	Trifolium spp.	clover
Trla2	Tral	Trollius laxus	American globeflower
Trpa5	Trpa	Trifolium parryi	Parry clover
Tyla		Typha latifolia	common cattail
Veca2	Vete	Veratrum californicum	false hellebore
Wyam		Wyethia amplexifolius	mulesears wyethia

# GRAMINOIDS

## (Grasses)

Agsc5	Aghy	Agrostis scabra	tickleggrass
Agst2		Agrostis stolonifera	carpet bentgrass
Alae		Alopecurus aequalis	shortawn foxtail
Ange		Andropogon gerardii	big bluestem
Bogr		Bouteloua gracilis	blue grama
Caaq3	Caaq1	Catabrosa aquatica	brookgrass
Caca4	Caca	Calamagrostis canadensis	bluejoint reedgrass
Capu		Calamagrostis purpurascens	purple reedgrass
Caru	Carul	Calamagrostis rubescens	pinegrass
Dain		Danthonia intermedia	timber danthonia
Dapa2	Dapa1	Danthonia parryi	Parry danthonia
Dece		Deschampsia cespitosa	tufted hairgrass
Ellal	Elda	Elymus dasystachyum	thickspike wheatgrass
Feid		Festuca idahoensis	Idaho fescue
Glbo		Glyceria borealis	northern mannagrass
GLYCE	GLYC	Glyceria spp.	mannagrass
Hobr2		Hordeum brachyantherum	meadow barley
Leci4		Leymus cinereus	basin wildrye
Leki2	Leki	Leucopoa kingii	king spikefescue
Mumo	Mumol	Muhlenbergia montana	Mountain muhly
Orhy		Oryzopsis micrantha	indian ricegrass
Pssp	Elsm	Pascopyrum smithii	western wheatgrass
POA	POA	Poa spp.	bluegrass
Pofe		Poa fendleriana	muttongrass
Popa2	Popa	Poa palustris	fowl bluegrass
Popr		Poa pratensis	Kentucky bluegrass
Pose		Poa secunda	Sandberg bluegrass
Pssp	Rosp	Pseudoroegneria spicata	bluebunch wheatgrass
Stco4	Stco	Stipa comata	needleandthread
Stne3	Stnel	Stipa nelsonii	columbia needlegrass

## (Sedges, Rushes, other graminoids and moss)

Caaq		Carex aquatilis	water sedge
Cacal2		Carex capillaris	hairlike sedge
Cadi6	Cadi	Carex disperma	softleaved sedge
Cadu6	Cael	Carex duriuscula	needleleaf sedge
Caeb		Carex ebenea	ebony sedge
Cafo3	Cafo	Carex foena	wind sedge
Cage2	Cage1	Carex geyeri	elk sedge
Caho5	Cahol	Carex hoodii	Hood sedge
Cain9	Cahe	Carex inops	sun sedge
Cami7	Cami4	Carex microptera	smallwing sedge
Cane2	Cane	Carex nebraskensis	Nebraska sedge
Capy3	Capy	Carex pyraenica	pyrenean sedge
CAREX	CARE	Carex spp.	sedge
Caro5	Caro3	Carex rossii	Ross sedge
Caro6	Caut	Carex rostrata	beaked sedge
Caru3	Caru	Carex rupestris	rock sedge
Casc12	Casc2	Carex scopulorum	cliff sedge
Casi2		Carex simulata	analogne sedge
Elpa3	Elpal	Eleocharis palustris	common spikesedge
Juba	Juara	Juncus balticus	baltic rush
Judr		Juncus drummondii	Drummond rush
Juen		Juncus ensifolius	swordleaf rush
Komy		Kobresia myosuroides	kobresia
Scmi2	Scmi	Scirpus microcarpus	panicled bulrush
moss	moss	moss spp.	moss

For the community type list below Level 1 (Zone) and Level 2 (Landscape Position) can be applied to polygons described for Levels 3, 4, 5, and 6. The list has level 2 (upland vs riparian) built into it as an information layer, but would be tracked separately in an attribute file. The general type vegetation categories in **CAPITAL LETTERS** (level 4) crosswalk into the RIS DATABASE (Level 5) and aggregate into Physiognomic Type (Level 3).

Community types are fitted to Levels 4 and 5. In each genus (overstory) group, the understories are grouped in the order of shrub, forb or graminoid i.e. CF/S; CF/F; CF/G and so forth. The genus group corresponds to the concept of Series as used in the literature for forests. Within each understory group, the community types are listed alphabetically by the genus of the understory. This list shows how level 6 fits into level 4. Level 6 also fits into level 5 (RIS categories) as explained in the attached classification hierarchy.

# **INTERIM LIST OF COMMUNITY TYPES - MEDICINE BOW NATIONAL FOREST**

Classification levels 2,3,4 and 6

## **PLANTS ACROMYN**

SYNONYM from Johnston (1987) or other source.

No asterisk indicates that the type was listed in Johnston (1987) or Alexander et al (1986).

## **FOREST**

### **CONIFEROUS FOREST (CF)**

#### **(Upland)**

Abla-Pien/Vace	Abla-Pien1/Vace	spruce-fir/dwarf huckleberry	CF/S
Abla-Pien/Vasc	Abla-Pien1/Vasc	spruce-fir/grouse whortleberry	CF/S
Abla-Pien/Cage2	Abla-Pien1/Cage1	spruce-fir/elk sedge	CF/G
*Abla-Pien/Caro5	Abla-Pien1/Caro3	spruce-fir/Ross sedge	CF/G
Abla-Pien/Caru3	Abla-Pien1/Caru	spruce-fir/rock sedge	CF/G
*Abla/Juco6	Alexander	fir/common juniper	CF/S
*Abla/Mare11	Alexander	fir/Oregon grape	CF/S
*Abla/Vasc	Cooper	fir/grouse whortleberry	CF/S
*Abla/Acru2	Alexander	fir/red baneberry	CF/F
*Abla/Arco9	Alexander	fir/heartleaf arnica	CF/F
*Abla/Erax4	Alexander	fir/fleabane	CF/F
*Abla/Caru	Alexander	fir/pinegrass	CF/G
*Abla/Cage2	Alexander	fir/elk sedge	CF/G
*Abla/Caro5	Alexander	fir/Ross sedge	CF/G
*Pien/Juco6	Pien1/Juco	spruce/common juniper	CF/S
*Pien/Vasc	Pien1/Vasc	spruce/grouse whortleberry	CF/S
*Pien/Arco9	Pien1/Arco2	spruce/heartleaf arnica	CF/F and so forth

Pico/Juco6	Pico/Juco	lodgepole pine/common juniper
Pico/Aruv	Pico/Arad	lodgepole pine/kinnikinnik
*Pico/Putr2	Pico/Putr	lodgepole pine/antelope bitterbrush
Pico/Shca	Pico/Shca	lodgepole pine/russett buffaloberry
Pico/Vasc	Pico/Vasc	lodgepole pine/grouse whortleberry
*Pico/Arco9	Pico/Arco2	lodgepole pine/heartleaf arnica
*Pico/Geca3	Alexander	lodgepole pine/Fremont geranium
*Pico/Pamy	Alexander	loegepole pine/paxistima
*Pico/Feid	Pico/Feid	lodgepole pine/Idaho fescue
*Pico/Caru	Alexander	lodgepole pine/pinegrass
Pico/Cage2	Pico/Cage1	lodgepole pine/elk sedge
Pico/Caro5	Pico/Caro3	lodgepole pine/Ross sedge
*Pico/lichen	Alexander	lodgepole pine/lichen
Pifl2/Juco6	Pifl/Juco	limber pine/common juniper
*Pifl2/Aruv	Pifl/Arad	limber pine/kinnikinnik
*Pifl2/Capu	Pifl/Capu	limber pine/purple reedgrass
Pifl2/Leki2	Pifl/Leki	limber pine/king spikefescue
*Pifl2/Pssp	Pifl/Pssp	limber pine/bluebunch wheatgrass
*Pipo/Jusc2	Pipo/Jusc	ponderosa pine/Rocky Mtn. juniper
*Pipo/Juco6	Pipo/Juco	ponderosa pine-common juniper
Pipo/Aruv	Pipo/Arad	ponderosa pine/kinnikinnik
*Pipo/Cemo	Pipo/Cemo	ponderosa pine-mountain mahogany
*Pipo/Phmo4	Pipo/Phmo	ponderosa pine/mountain ninebark
*Pipo/Putr2	Pipo/Putr	ponderosa pine/bitterbrush
*Pipo/Artr2-Feid	Pipo/Artr2-Feid	ponderosa pine/big sagebrush-Idaho fescue
*Pipo/Feid	Pipo/Feid	ponderosa pine/Idaho fescue
*Pipo/Leki2	Pipo/Leki	ponderosa pine/king spikefescue
Pipo/Cage2	Pipo/Cage1	ponderosa pine/elk sedge
Pipo/Caro5	Pipo/Caro3	ponderosa pine/Ross sedge
*Pipo/Cain9	Alexander	ponderosa pine/sun sedge
*Pipo-Psme/Phmo4	Pipo-Psme/Phmo	ponderosa pine-Douglas-fir/mountain ninebark
*Pipo-Psme/Mumo	Pipo-Psme/Mumo1	ponderosa pine-Douglas-fir/mountain muhly
*Psme/Aruv-Juco6	Psme/Arad-Juco	Douglas-fir/kinnikinnik-common-juniper
*Psme/Cemo2	Psme/Cemo	Douglas-fir/mountain mahogany
*Psme/Jaam4	Psme/Jaam	Douglas-fir/cliff jamesia
*Psme/Mare11	Alexander	Douglas-fir/Oregon-grape
Psme/Phmo4	Psme/Phmo	Douglas-fir/mountain ninebark
*Psme/Caru	Alexander	Douglas-fir/pinegrass
*Psme/Feid	Alexander	Douglas-fir/Idaho fescue
*Psme/Cage2	Alexander	Douglas-fir/elk sedge
*Psme/Caro5	Psme/Caro3	Douglas-fir/Ross sedge

**(Riparian)**

*Abla-Pien/RIBES	Abla-Pien1/RIBE	spruce-fir/currant
*Abla-Pien/Sagl	Abla-Pien1/Sagl	spruce-fir/grayleaf willow
*Abla-Pien/Arla8	Abla-Pien1/Arla	spruce-fir/broadleaf arnica
*Abla-Pien/Libo3	Abla-Pien1/Libo	spruce-fir/twinflower
*Abla-Pien/Meci3	Abla-Pien1/Meci	spruce-fir/mountain bluebells
*Abla-Pien/Setr	Abla-Pien1/Setr	spruce-fir/arrowleaf groundsel
Abla-Pien/Caca4	Abla-Pien1/Caca4	spruce-fir/bluejoint reedgrass
*Abla-Pien/moss	Abla-Pien1/moss	spruce-fir/moss
*Abla/Arla8	Alexander	fir/broadleaf arnica
*Abla/Gatr3	MT	fir/sweet-scented bedstraw
*Abla/Libo3	Alexander	fir/twinflower
*Abla/Pera	Alexander	fir/sickletop lousewort
*Abla/Caca4	MT	fir/bluejoint reedgrass
*Abla/moss	Alexander	fir/moss
*Pico/Libo3	Alexander	lodgepole pine/twinflower
*Pico/Casc12	I REG	lodgepole pine/Holm's Rocky Mountain sedge
*Pien/Cale4	Pien1/Cale1	Engelmann spruce/elkslip marshmarigold
*Pien/Eqar	Alexander	Engelmann spruce/field horsetail
*Pien/Gatr3	Jones	Engelmann spruce/sweet-scented bedstraw
*Pien/Libo3	Pien1/Libo	Engelmann spruce/twinflower
*Pien/Mast4	Alexander	Engelmann spruce/wild lily-of-the-valley
*Pien/Cadi6	Pien1/Cadi	Engelmann spruce/softleaved sedge
*Pien/moss	Alexander	Engelmann spruce/moss
*Pien-Pipu/Gatr3	Pien1-Pipu/Gatr3	Engelmann spruce-blue spruce/sweet-scented bedstraw
*Pipu/Alin2	Pipu/Alint	blue spruce/thinleaf alder
*Pipu/Amal2-Cose16	Pipu/Amal-Swse	blue spruce/Saskatoon serviceberry-red-osier dogwood
*Pipu/Cose16	Alexander	blue spruce/red-osier dogwood
Pipu/Arco9	Pipu/Arco2	blue spruce/heartleaf arnica
*Pipu/Eqar	Alexander	blue spruce/field horsetail
*Pipu/Popr	Alexander	blue spruce/Kentucky bluegrass
*Pipu-Pien1/Eqar	Pipu-Pien1/Eqar	blue spruce-Engelmann spruce/field horsetail
*Pipo/Cose16	SW MT	ponderosa pine/red-osier dogwood
*Pipo/Prvi	CN MT	ponderosa pine/common chokecherry
*Pipo/Popr	DeVelice 1986	ponderosa pine/Kentucky bluegrass
*Psme/Cose16	MT	Douglas-fir/red-osier dogwood

# DECIDUOUS FOREST (DF)

## (Upland)

Potr5/Juco	Potr1/Juco	aspen/common juniper
*Potr5/Amal2-Prvi	Potr1/Amal-Pavi	aspen/S.serviceberry-common chokecherry
*Potr5/Artr2	Potr1/Artr	aspen/big sagebrush
*Potr5/Ceve	Potr1/Ceve	aspen/snowbrush ceanothus
*Potr5/Syor2	Potr1/Syor1	aspen/whortleleaf snowberry
Potr5/Lala3	Potr1/Lale3	aspen/aspen peavine
*Potr5/Luar	Alexander	aspen/silvery lupine
*Potr5/Raal	Alexander	aspen/plantainleaf buttercup
*Potr5/Wyam	Alexander	aspen/mulesears wyethia
Potr5/Caru3	Potr1/Caru	aspen/rock sedge
Potr5/Cage2	Potr1/Cage1	aspen/elk sedge
*Potr5-Abla/Mare11	Alexander	aspen-subalpine fir/Oregon grape
*Potr5-Abla/Prvi	Alexander	aspen-subalpine fir/common chokecherry
*Potr5-Abla/Shca	Alexander	aspen-subalpine fir/russett buffaloberry
*Potr5-Abla/Syor2	Alexander	aspen-subalpine fir/whortleleaf snowberry
*Potr5-Abla/Arco9	Alexander	aspen-subalpine fir/heartleaf arnica
*Potr5-Abla/Lifi	Alexander	aspen-subalpine fir/fernleaf ligusticum
*Potr5-Abla/Pera	Alexander	aspen-subalpine fir/sickletop lousewort
*Potr5-Pico/Caru	Alexander	aspen-lodgepole pine/pinegrass
*Potr5-Psme/Amal2	Alexander	aspen-Douglas-fir/Saskatoon serviceberry
*Potr5-Psme/Caru	Alexander	aspen-Douglas-fir/pinegrass

## (Riparian)

*Acne2/Cose16	IREG	boxelder/red-osier dogwood
*Acne2/Prvi	CN MT	boxelder/common chokecherry
*Poan3/Alin2-Cose16	Poan3/Alint-Swse	narrowleaf cottonwood/S. serviceberry-red-osier dogwood
*Poan3/Beoc2	IREG	narrowleaf cottonwood/water birch
*Poan3/Cose16	IREG	narrowleaf cottonwood/red-osier dogwood
*Poan3/Rhtr	IREG	narrowleaf cottonwood/skunkbrush sumac
*Poan3/Rowo	IREG	narrowleaf cottonwood/Wood's rose
Poan3/Saex-Beoc2	Poan3/Saex-Befo	narrowleaf cottonwood/coyote willow-water birch
*Poan/Popr	Jones, MT, IREG	narrowleaf cottonwood/Kentucky bluegrass
*Poba2/Cose16	Poba/Swse	balsam poplar/red-osier dogwood
Podem/Syoc-Saex	Posa/Syoc-Saex	plains cottonwood/western snowberry-coyote willow
*Potr5/Beoc2	IREG	aspen/water birch
*Potr5/Cose16	MT, IREG	aspen/red-osier dogwood
*Potr5/Mare11	CN MT	aspen/Oregon grape

*Potr5/Rowo	IREG	aspen/Wood's rose
*Potr5/Sage2	SW MT	aspen/Geyer willow
*Potr5/Gevi2	Alexander	aspen/sticky geranium
*Potr5/Hesp6	Potr1/Hesp	aspen/cow parsnip
Potr5/Lipo	Potr1/LIGU	aspen/Porter's ligusticum
*Potr5/Osoc	CN MT	aspen/western sweetroot
*Potr5/Ptaq	Potr1/Ptaq	aspen/bracken fern
*Potr5/Thfe	Potr1/Thfe	aspen/Fendler meadowrue
*Potr5/Veca2	Alexander	aspen/false hellebore
*Potr5/Popr	MT	aspen/Kentucky bluegrass
*Potr5/Egar	Alexander	aspen/field horsetail
 *Potr5-Abla/Thfe	 Alexander	 aspen-subalpine fir/Fendler meadowrue

#### WOODLAND

##### CONIFEROUS WOODLAND (CW)

###### (Upland)

*Jusc2/Artr2	Jusc/Artr	Rocky Mountain juniper/big sagebrush
*Jusc2/Cemo2	Jusc/Cemo	Rocky Mountain juniper/mountain mahogany
*Jusc2/Putr2	Jusc/Putr	Rocky Mountain juniper/antelope bitterbrush
Jusc2-Pssp	Jusc/Rosp	Rocky Mountain juniper/bluebunch wheatgrass

##### DECIDUOUS WOODLAND (DW)

###### (Upland)

*Quga/Amal2	Quga/Amal	Gambel oak/Saskatoon serviceberry
*Quga-Prvi/Pamy	Quga-Pavy/Pamy	Gambel oak-common chokecherry/myrtle paxistima
*Quga/Syor2	Quga/Syor1	Gambel oak/whortleleaf snowberry

#### SHRUBLAND

##### SHRUBLAND NON-WILLOW (SHNW)

###### (Upland)

*Amal2-Prvi/Viam	Amal-Pavi/Viam	S.serviceberry-common chokecherry/American vetch
Amal2/Putr2-Pssp	AMEL/Putr-Rosp	S.serviceberry/antelope bitterbrush-bluebunch wheatgrass
Amal2/Syor2-Artr2	AMEL/Syor1-Artr	S.serviceberry/whortleleaf snowberry-big sagebrush
Amal2/Cage2	AMEL/Cage1	Saskatoon Serviceberry/elk sedge
 Artr2-Putr2/Ellal	 Artr-Putr/Elda	 big sagebrush-antelope bitterbrush/thickspike wheatgrass
*Artr2-Putr2/Pssm	Artr-Putr/Agsm	big sagebrush-antelope bitterbrush/western wheatgrass
Artr2/Feid	Artr/Feid	big sagebrush/Idaho fescue
*Artr2/Leki2	Artr/Leki	big sagebrush/king spikefescue
Artr2/Pssp	Artr/Rosp	big sagebrush/bluebunch wheatgrass
*Artr2/Pssm	Artr/Agsm	big sagebrush/western wheatgrass

*Artr2/Orhy	Artr/Orhy	big sagebrush/indian ricegrass
Artr2/Stco4	Artr/Stco1	big sagebrush/needleandthread
*Artr2/Stne3	Artr/Stne	big sagebrush/Columbia needlegrass
Putr2-Artr2/Feid	Putr-Artr/Feid	antelope bitterbrush-big sagebrush/Idaho fescue
Putr2-Artr2/Pssp	Putr-Artr/Agsm	antelope bitterbrush-big sagebrush/western wheatgrass
*Putr2/Mumo	Putr/Mumol	antelope bitterbrush/mountain muhley
*Putr2/Stco4	Putr/Stco1	antelope bitterbrush/needleandthread
*Cemo2-Rhtr/Ang	Cemo-Rhart/Ang	mountain mahogany-skunkbrush sumac/big bluestem
*Cemo2/Ella1	Cemo/Elda	mountain mahogany/thickspike wheatgrass
Cemo2/Feid	Cemo/Feid	mountain mahogany/Idaho fescue
Cemo2/Pssp	Cemo/Rosp	mountain mahogany/bluebunch wheatgrass
*Cemo2/Stco4	Cemo/Stco1	mountain mahogany/needleandthread
*Droc/Caru3	Droc/Caru	mountain dryad/rock sedge
*Hodu/Rice	Hodu/Rice	ocean-spray/wax currant
*Syoc/Pssm	Syoc/Agsm	western snowberry/western wheatgrass

**SHRUBLAND NON-WILLOW  
(Riparian)**

*Acgl/Cose16	Acgl/Swse	Mountain maple/red-osier dogwood
Alin2-Beoc2/SALIX	Alint-Befo/SALI	thinleaf alder-water birch/willow
*Alin2-Beoc2/Caaq	Alint-Befo/Caaq	thinleaf alder-water birch/water sedge
*Alin2/Egar	IREG	thinleaf alder/field horsetail
*Arca13/Feid	Arca3/Feid	silver sagebrush/Idaho fescue
*Arca13/Pssm	Arca3/Agsm	silver sagebrush/western wheatgrass
*Artr2/Leci4	Artr/Leci	big sagebrush/basin wildrye
*Beoc/Cose16	IREG	water birch/red-osier dogwood
*Cose16/Gatr3	IREG	red-osier dogwood/sweet-scented bedstraw
*Cose16/Hesp	Cose/Hesp	red-osier dogwood/cow parsnip
*Droc/Caru3	Droc/Caru	Mtn. dryad/rock sedge
*Prvi-Syoc/Pssm	Pavi-Syoc/Elsm	chokecherry-western snowberry/western wheatgrass

*Prvi/Rowo	CN MT	chokecherry/Wood's rose
*Pofr4/Feid	Pefl/Feid	shrubby cinquefoil/Idaho fescue
Pofr4/Dece	Pefl/Dece	shrubby cinquefoil/tufted hairgrass
*Pofr4/Popr	CN MT	shrubby cinquefoil/Kentucky bluegrass

# **SHRUBLAND WILLOW (SHW)**

## **(Riparian - Willow)**

Tall Willow		
*Sabe2	IREG	Bebb willow
Sabo2-SALIX/Caca4	Sabo1-SALI/Caca	Booth willow-willow/bluejoint reedgrass
Sabo2-SALIX/Caro6	Sabo1-SALI/Caut	Booth willow-willow/beaked sedge
*Sadr/Caca4	Sadr/Caca	Drummond willow/bluejoint reedgrass
Saex-SALIX/POA	Saex-SALI/POA	coyote willow-willow/Kentucky bluegrass
Saex-SALIX/Caca4-Eqar	Saex-SALI/Caca-Eqar	coyote willow-willow/bluejoint reedgrass-field horsetail
*Saex/Rowo	IREG	coyote willow/Wood's rose
*Saex/Popr	IREG	coyote willow/Kentucky bluegrass
Sage2-SALIX/Caca4	Sage-SALI/Caca	Geyer willow-willow/bluejoint reedgrass
*Sage2-SALIX/Caro6	Sage-SALI/Caut	Geyer willow-willow/beaked sedge
*Sage2/Caca4	MT, IREG	Geyer willow/bluejoint reedgrass
*Sage2/Dece	CN MT	Geyer willow/tufted hairgrass
Sage2/Popa2	Sage/Popa	Geyer willow/fowl bluegrass
*Sage2/Popr	Jones, MT, IREG	Geyer willow/Kentucky bluegrass
*Sage2/Caaq	IREG	Geyer willow/water sedge
*Sage2/Caro6	Jones, MT, IREG	Geyer willow/beaked sedge
*Sala	MT	Pacific willow
*Salu/Caca4	CN MT	yellow willow/bluejoint reedgrass
*Salu/Popr	CN MT	yellow willow/Kentucky bluegrass
*Salu/Caro6	CN MT	yellow willow/beaked sedge
Salu/Eqar	Salu/Eqar	yellow willow/field horsetail
*Sapl2/Cale4	Saphp/Cale1	planeleaf willow/elkslip marigold
*Sapl2/Caca4	IREG	planeleaf willow/bluejoint reedgrass
*Sapl2/Dece	Saphp/Dece	planeleaf willow/tufted hairgrass
Sapl2/Caaq	Saphp/Caaq	planeleaf willow/water sedge
*Sapl2/Casc12	Saphp/Casc2	planeleaf willow/Holm's Rocky mountain sedge
Short Willow		
*Saar4/Geror	Saar/Acro	arctic willow/golden avens

*Saca4-SALIX/Caaq	Saca-SALI/Caaq	sageleaf willow-willow/water sedge
*Sag1-SALIX/CAREX	Sag11-SALI/CARE	grayleaf willow-willow/sedge
*Sag1-Sabr/Dece	Sag11-Sabr/Dece	grayleaf willow-barrenground willow/tufted hairgrass
*Sag1/Geror	Sag11/Acro	grayleaf willow/golden avens
Sawo/Frvi	Sawo/Frvi	wolf willow/Virginia strawberry
Sawo/Dece	Sawo/Dece	wolf willow/tufted hairgrass
Sawo/Caca4	Sawo/Caca	wolf willow/bluejoint reedgrass
Sawo/Caaq	Sawo/Caaq	wolf willow/water sedge
Sawo/Caro6	Sawo/Caut	wolf willow/beaked sedge

#### FORBLAND

#### FORBLAND (FO) (Upland)

*Droc/Caru	Droc/Caru	mountain dryad/pinegrass
Geror-TRIFO/Dece	Acro-TRIF/Dece	golden avens-clover/tufted hairgrass
Geror/Trda2	Acro/Trda	golden avens/whiproot clover
*Geror/Pobi6	Acro/Bibi2	golden avens/American bistort
Sipr/Caeb	Sipr/Caeb	sibbaldia/ebony sedge
*Sipr/Capy3	Sipr/Capy	sibbaldia/pyrenean sedge

#### (Riparian)

*Caco6/Cale4	Caco2/Cale1	brook-cress/elkslip marshmarigold
*Cale4	IREG	elkslip marigold
*Cale4/Serh	Cale1/Clrh	elkslip marshmarigold/rose-crown
*Ciar4	IREG	cirsium arvense
*Cisc3/Aqco	Cisc/Aqco	alpine thistle/Colorado columbine
*Eqar	IREG	field horsetail
*Lipo/Lupa8	Lipo/Lupa3	Porter ligusticum/lodgepole lupine
*Mear4	IREG	field mint
*Meci3	IREG	mountain bluebells
*Meci3/Dece	Meci/Dece	mountain bluebells/tufted hairgrass
*Migu	IREG	yellow monkeyflower
*Rona2	IREG	watercress
*Prpa2/Dece	Prpa/Dece	Parry primrose/tufted hairgrass
*Raaq	IREG	aquatic buttercup
*Saod2/Dece	Miod/Dece	brook saxifrage/tufted hairgrass
*Setr/Lifi	Setr/Lifi	arrowleaf groundsel/fernleaf ligusticum
*Trla2-Lifi/Erpe3	Tral-Lifi/Erpel	globeflower-fernleaf ligusticum/peregrine fleabane
*Trpa5/Dece	Trpa/Dece	Parry clover/tufted hairgrass
*Tyla	MT, IREG	common cattail

## GRASSLAND

### GRASSLAND (GRS)

#### (Upland)

Dece/Geror	Dece/Acro	tufted hairgrass/golden avens
Dapa2/Feid	Dapa1/Feid	Parry danthonia/Idaho fescue
*Dain/Podi2	Dain/Podi	timber oatgrass/varileaf cinquefoil
*Feid/Dece	Feid/Dece	Idaho fescue/tufted hairgrass
*Mumo/Ella1	Mumo1/Elda	mountain muhley/thickspike wheatgrass
Stco4/Caeb	Stco1/Caeb	needleandthread/ebony sedge
Stco4/Bogr	Stco1/Bogr	needleandthread/blue grama
*Pssm/Pofe	Agsm/Pofe	western wheatgrass/muttongrass
*Pssm/Stco4	Agsm/Stco1	western wheatgrass/needlegrass
Pssp/Pose	Rosp/Pose	bluebunch wheatgrass/sandberg bluegrass

### GRASSLAND (GRM)

#### (Upland)

*Cadu6/Sede2	Cael/Sede	needleleaf sedge/selaginella
*Cafo3/Geror	Cafo/Acro	wind sedge/golden avens
*Caru3/Komy	Caru/Komy	rock sedge/kobresia
*Caru3/Trda2	Caru/Trda	rock sedge/whiproot clover
*Komy/Geror-Caru3	Komy/Acro-Caru	Kobresia/golden avens-rock sedge
*Komy/Trda2	Komy/Trda	Kobresia/whiproot clover

### (Riparian) (GRS)

*Agsc5	IREG	ticklegrass
*Agst2	MT, IREG	carpet bentgrass
*Alae	IREG	shortawn foxtail
*Caaq3/Caaq	Caaq1/Caaq	brookgrass/water sedge
*Dain	IREG	timber danthonia
*Dece	MT, IREG	tufted hairgrass
Dece/CAREX	Dece/CARE	tufted hairgrass/sedge
*Dece/Cale4	Dece/Cale1	tufted hairgrass/marsh marigold
*Caca4	MT, IREG	bluejoint reedgrass
*Caca4-Casc12/Meci3	Caca-Casc2/Meci	bluejoint reedgrass-Holm's Rocky Mountain Sedge/mtn. bluebells
*GLYCE	IREG	mannagrass
*Glbo	SW MT	northern mannagrass
*Hobr2	IREG	meadow barley
*Popa2	MT	fowl bluegrass
*Popr	MT, IREG	Kentucky bluegrass

(GRM)

*Caaq	Jones, MT, IREG	water sedge
Caaq/Caro6	Caaq/Caut	water sedge/beaked sedge
*Caaq/Pegr2	Caaq/Pegr1	water sedge/elephanthead lousewort
*Caaq/Caho5	Caaq/Cahol	water sedge/Hood sedge
*Caca12/Povi6	Caca3/Bivi	hairlike sedge/American bistort
*Caro6	Jones, MT, IREG	beaked sedge
*Cami7	Jones	smallwing sedge
Cami7/Dece	Cami4/Dece	smallwing sedge/tufted hairgrass
*Cane2	MT, IREG	Nebraska sedge
*Cane2/Caaq3-Juba	Cane/Caaq1-Juar	Nebraska sedge/brookgrass-Baltic rush
*Cane2/Dece	Cane/Dece	Nebraska sedge/tufted hairgrass
Casi2/Dece	Casi/Dece	short-beaked sedge/tufted hairgrass
*Casc12	MT, IREG	Holm's Rocky Mountain sedge
*Casc12/Dece	Casc2/Dece	Holm's Rocky Mountain sedge/tufted hairgrass
*Casc12/Cale4	Casc2/Cale1	Holm's Rocky Mountain sedge/elkslip marshmarigold
*Elpa3	MT, IREG	creeping spikerush
*Elpa3/CAREX	Elpa/CARE	creeping spikerush/sedge
*Juba	Jones, MT, IREG	Baltic rush
*Juba/CAREX	Juar/CARE	Baltic rush/sedge
*Judr/CAREX	Judr/CARE	Drummond rush/sedge
*Juen	IREG	swordleaf rush
*Scmi2	IREG	panicled bulrush

WORKING VEGETATION CLASSIFICATION HIERARCHY FOR IRI MAPPING ON THE MBNF 1/93 Version

Level 1 (Zone)	Level 2 (Landscape Position)	Level 3 (Physiognomic Type)	Level 4 (General Type)	Level 5 (RIS)	Level 6 (Community Type)
01 Alpine	01 Upland	01 Forest	01 CF	TRE	See list of community types nested into levels 4 and 05 5.
02 Subalpine	02 Freshwater Riparian	02 Woodland	02 DF	SHR	
03 Montane	03 Saline Riparian	03 Shrubland	03 CW	FOR	
04 Foothills		04 Forbland	04 DW	GRA	
05 Great Basin		05 Grassland	05 SHNW	(OTHER RIS	
06 Great Plains			06 SHW	TYPES ALSO	
			07 FO	i.e.	
			08 GR	TSF	
			09 CF/S	TLP	
			10 CF/F	SSA	
			11 CF/G	SWI	
			12 DF/S	GPO	
			13 DF/F	GHA etc	
			14 DF/G		
			15 CW/S		
			16 CW/F		
			17 CW/G		
			18 DW/S		
			19 DW/F		
			20 DW/G		
			21 SHNW/S		
			22 SHNW/F		
			23 SHNW/G		
			24 SHW/S		
			25 SHW/F		
			26 SHW/G		
			27 FO/F		
			28 FO/G		
			29 GRS		
			30 GRM		

CF = coniferous forest

DF = deciduous forest

CW = coniferous woodland

DW = deciduous woodland

SHNW - shrubland (non-willow)

SHW = shrubland (willow)

FO = forbland

GR = grassland

GRS = grassland with grasses (Poaceae)

GRM = grassland - graminoids other than grasses (Juncaceae, Cyperaceae)

Ferns are grouped with forbs; mosses are non-graminoid grass types.

S = shrubs F = forbs (and ferns) G = grasses or other graminoid (understories)

# CROSSWALK OF RIS CATEGORIES INTO VEGETATION CLASSIFICATION FRAMEWORK

FOREST		WOODLAND		SHRUBLAND		FORBLAND	GRASSLAND	
TRE		TRE & SHR		SHR		FOR	GRA	
Coniferous Forest	Deciduous Forest	Coniferous Woodland	Deciduous Woodland	non-willow	willow	forbland	grass	graminoids
TSF	TCW	*TPJ	*TGO	SSA	SWI	FAV	GNE	GKO
TLP	TAA		*SGO	SMS		FLI	GWH	GWE
TLI				SSC		FCL	GPO	
TPP				SSE		FNA	GMU	
TDF				SSN			GFE	
				SGR			GPG	
				SAD			GRG	
				SAL			GHA	
<	<		<	*SKR			GOA	

\* There is no Woodland category in RIS. Pinyon-juniper is considered Forest, and Gambel Oak is divided among shrubland and Forest depending on the form of the plant; krumholz is placed in the shrubland category. I would recommend that krumholz be placed with forest and that pinyon, juniper and Gambel oak be considered woodlands for vegetation classification purposes.

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Note: This is a DRAFT list of selected examples to illustrate how this works. All community types can be fitted to this framework.

# NESTING OF COMMUNITY TYPES INTO THE VEGETATION CLASSIFICATION

TSF	TBS	CONIFEROUS FOREST TLP	TLI	TPP	TDF
Engelmann spruce forest subalpine fir forest spruce-fir forest Engelmann-spruce-blue spruce	blue spruce forest	lodgepole pine forest	limber pine forest	ponderosa pine forest	Douglas-fir forest
(Pien; Abla; Abila-Pien; Pien-Pipu)	(Pipu)	(Pico)	(Pifl)	(Pipo)	(Psme)
(upland) (CF/S) A-P/Vace A-P/Vasc P/Vasc P/Juco6	(riparian) (CF/S) P/Alin2 P/Amal2-Cose16	(upland) (CF/S) P/Juco6 P/Vasc P/Aruv P/Shca P/Putr2	(upland) (CF/S) P/Juco6 P/Aruv	(upland) (CF/S) P/Jusc P/Juco6 P/Cemo P/Putr2 P/Artr2 P/Phmo4	(upland) (CF/S) P/Phmo4 P/Aruv-Juco6 P/Cemo P/Jaam P/Caro6 P-P/Phmo4
(CF/F) A-P/Arla8 A-P/Libo3	(CF/F) P/Arco9	(CF/F) P/Arco9	(CF/G) P/Capu P/Leki2 P/Pssp	(CF/G) P/Caro5 P/Cage2 P/Leki2 P/Feid P/Popr	(CF/G) P-P/Mumo
(CF/G) A-P/Caru3 A-P/Caro5 A-P/Cage2		(CF/G) P/Cage2 P/Caro5 P/Feid		(riparian) (CF/F) P/Ptaq	
(riparian) (CF/S) A-P/Sagl		(riparian) (CF/G) P/Casc12		(CF/G) P/Popr	
(CF/F) A-P/Meci3 A-P/Setr					
(CF/G) A-P/Caca4 A-P/Moss	(CF/F) P-P/Gatr3 P/Libo3 P/Gatr3	(CF/G) P/Cale4 P/Arco9	(CF/G) P/Cadi6		

DECIDUOUS FOREST

TCW  
cottonwood forest  
  
(Poan3; Poba; Podem)  
  
(riparian)  
(DF/S)  
    Poan3/Saex-Beoc2  
    Poan3/Alin2-Cose16  
  
    Poba/Cose16  
  
    Podem/Syoc-Saex  
    Podem/Saex

TAA  
aspen forest  
  
(Potr5)  
  
(upland)  
(DF/S)  
    P/Ceve  
    P/Juco6  
    P/Artr2  
    P/Syor2  
    P/Amal-Pavi  
  
(DF/F)  
    P/Lale3  
  
(DF/G)  
    P/Caru3  
    P/Cage2  
  
(riparian)  
(DF/S)  
    P/Sage2  
    P/Beoc2  
    P/Mare11  
    P/Cose16  
    P/Rowo  
  
(DF/F)  
    P/Osoc  
    P/Lipo  
    P/Ptaq  
    P/Thefe  
    P/Hesp  
  
(DF/G)  
    P/Popr

WOODLAND

Coniferous woodland

TRE - TPJ

Juniper woodland

(Jusc)

(upland)

(CWO/S)

Jusc/Artr2

Jusc/Cemo2

Jusc/Putr2

(WO/G)

Jusc/Pssp

Deciduous woodland

TRE - TGO and SHR - SGO

Gambel oak woodland

(Quga)

(upland)

(DWO/S)

Quga/Amal2

Quga/Syor2

Quga/Prvi-Pami

# SHRUBLAND

## non-willow shrubland

SSA Sagebrush	SMS Mtn. mahogany, bitterbrush, skunkbrush sumac	SSC shrubby cinquefoil	SSE serviceberry	SSN snowberry	SAD dryad
(Artr2; Arca13)	(Cemo2; Putr2; Rhar)	(Pofr4)	(Amal2)	(Syoc)	(Droc)
(upland) (SHNW/G) Artr2-Putr2/Ellal Artr2-Putr2/Pssm  A/Feid A/Feth A/Pssm A/PSsp A/Orhy A/Stco4 A/Stne  (riparian) (SHNW/G) Arca13/Feid Arca13/Pssm  Artr2/Leci4	(upland) (SHNW/G) Putr2-Artr2/Feid Putr2-Artr2/Pssp Putr2-Artr2/Mumol Putr2-Artr2/Stco4  Cemo2-Rhar4/Ange Cemo2/Feid Cemo2/Pssp Cemo2/Ellal Cemo2/Stco4  *Hodu/Rice	(upland) (SHNW/G) Pofr4/Dece Pofr/Feid Pofr/Popr	(upland) (SHNW/S) A/Syor2-Artr2 A/Putr2-Pssp A/Prvi/Viam  (SHNW/G) A//Cage2	(upland) (SHNW/G) Syoc/Pssm	(upland) (SHNW/G) Droc/Caru3

\* Hodu not in a RIS category.

# SHRUBLAND

SAL  
thinleaf alder;  
water birch

(Alin2; Beoc2)

(riparian)  
(SHNW/S)  
\*Acgl/Cose16

Alin2-Beoc2/SALIX

Beoc2/Cose16  
Prvi/Rowo

(SHNW/F)  
Cose16/Gatr3  
Cose16/Hesp

(SHNW/G)  
Alin2-Beoc2/Caaq  
Alin2/Beoc2/Eqar

Prvi-Syoc/Pssm

SWI  
willows

(SALIX)

(riparian)  
TALL WILLOWS  
(SHW/S)  
Sabe2

Saex/Rowo

(SHW/G)  
Sabo2-SALIX/Caca4  
Sabo2-SALIX/Caro6

Sadr/Caca4

Saex-SALIX/POA  
Saex-SALIX/Caca4-Eqar

Sage2-SALIX/Caca4  
Sage2-SALIX/Caro6  
Sage2/Caca4  
Sage2/Popa2  
Sage2/Caaq  
Sage2/Caro6  
Sage2/Dece  
Sage2/Popr

Sala

Salu/Caca4  
Salu/Caro6  
Salu/Popr  
Salu/Eqar

Sapl2/Cale4  
Sapl2/Dece  
Sapl2/Caca4  
Sapl2/Caaq  
Sapl2/Casc12

SHORT WILLOWS  
(SHW/F)  
Saar/Geror

Sagl/Geror

Sawo-Frvi

(SHW/G)  
Saca4-SALIX/Caaq

Sagl-SALIX/CAREX  
Sagl-Sabr/Dece

Sawo/Dece  
Sawo/Caca4  
Sawo/Caro6  
Sawo/Caaq

\*Acgl not in a RIS category.

## FORBLAND

FAV (golden avens)	FLI (ligusticum)	FCL (clover)	FNA (Other native forbs)	FWE (thistle and others)	FCA (cattail)
(Geror)	(Lipo)	(TRIFO)		(CIRSI + other weedy, exotic forbs)	(TYLA)
(upland) (FO/F) G/Trda2 G/Pobi6	(riparian) (FO/F) Lipo/Lupa8	(upland) (FO/F) Trpa5/Geror	(upland) (FO/G) Sipr/Caeb Sipr/Capy3	(riparian) (FO/F) Ciar	(riparian) (FO/F) Tyla
(FO/G) G-TRIFO/Dece		(riparian) (FO/G) Trpa5/Dece	(riparian) (FO/F) Caco6/Cale4 Cale4 Cale4/Clrh *Cisc3/Aqco Eqar Mear Meci3 Migu Rona2 Raaq  (FO/G) Meci3/Dece Prpa/Dece Saod2/Dece Setr/Lifi		

# GRASSLAND

## GRA

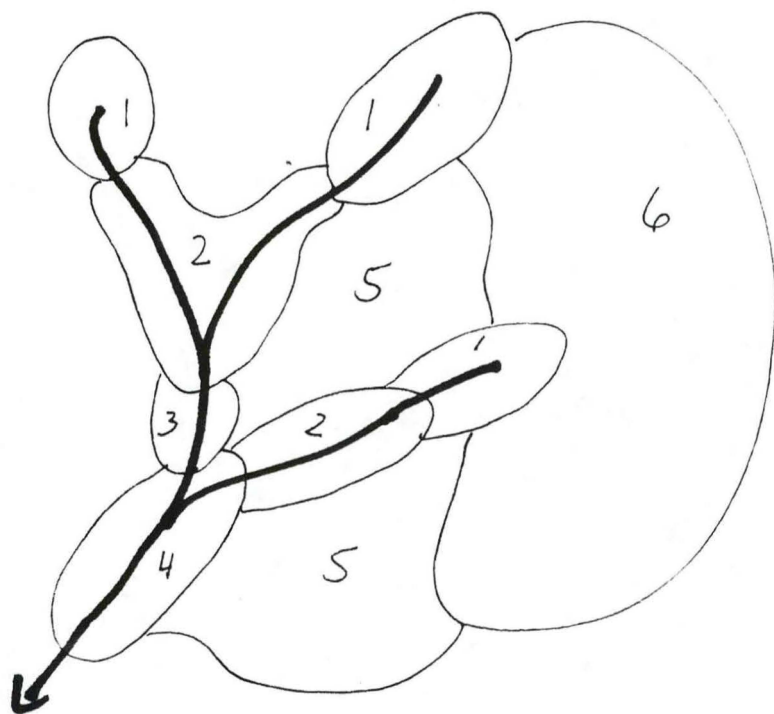
### Taxonomic grasslands

GNE needlegrass	GWH wheatgrass	GPO bluegrass	GMU muhley	GFE fescues	GRG bluejoint reedgrass (Caca4)	GHA hairgrass (Dece)	GOA oatgrass (Dain;Dapa2)
(STIPA; Stco4; Stne)	(Pssm; Pssp)	(POA; Popr) Popa2)	(Mumol)	(Feid)			
(upland) GR Stco4/Caeb Stco4/Bogr	(upland) GR Pssp/Pose Pssp/Pofr  Pssme/Stco4	(riparian) GR Popr Popa2	(upland) GR Mumol/Ella1	(upland) GR Feid/Dece	(riparian) GR Caca4-Casc12/ Meci3	(riparian) GR Dece/Geror Dece/Cale4 Dece/CAREX	(upland) GR Dapa2/Feid Dain/Podi2

### Grasslands name for other graminoid species (sedges, rushes)

GKO (kobresia)	GWE (sedgeland, rushlands)
(Komy)	(CAREX, JUNCUS, ELEOCHARIS)
(upland) GRM Komy-Geror-Caru3 Komy/Trda	(upland) GRM Cadu6/Sede2 Cafo3/Geror Caru3/Komy Caru3/Trda2
	(riparian) GRM Elpa3/CAREX Caca12/Povi6 Caaq/Caro Caaq/Pegr2 Cami7/Dece Cane2/Dece Casi2/Dece
	Casc12/Dece Casc12/Cal4 Juba/CAREX Judr/CAREX

Example of use of nested classification. This describes a subalpine spruce-fir forest, a montane riparian area + a subalpine lodgepole pine forest. The community types specify the vegetation within a RIS category and the RIS categories nest into physiognomic levels. The same system can be used for existing or Potential Natural vegetation description.



Level Polygm	→	1	2	3	4	5	6
1		02	02	01	09 [CF/s]	TSF	Abla-Pien/Meci3
2		02	02	01	09 [CF/s]	TSF	Abla-Pien/Gatr3
3		03	02	03	24 [SHW/G]	SWI	Sapl2 / Caag
4		03	02	05	29 [Gr]	GHA	Dece/CAREX
5		03	01	01	08 [CF/s]	TLP	Pico / Jueo
6		02	01	01	08 [CF/s]	TSF	Abla-Pien/Vasc